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LITIGATION TECHNICAL SUPPORT AND SERVICES

ROCKY MOUNTAIN ARSENAL
BUILDING 1727 SUMP INTERIM
RESPONSE ACTION ASSESSMENT


DRAFT FINAL TREATABILITY STUDY
JULY 1987
CONTRACT NUMBER DAAK11-84-D-0016
TASK NUMBER 30

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13. ABSTRACT (Maximum 200 words) BASED ON THE LITERATURE REVIEW, ELECTROCHEMICAL PRECIPITATION AND ACTIVATED ALUMINA ADSORPTION WERE JUDGED TO BE THE MOST PROMISING TECHNOLOGIES FOR INTERIM TREATMENT OF WASTEWATER IN SUMP 1727. SECTIONS OF THE REPORT DISCUSS THE FOLLOWING: 1. RAW WATER CHARACTERISTICS 2. PROPOSED TREATMENT LEVELS FOR DISCHARGE TO THE RMA SANITARY SEWER 3. TREATABILITY TEST METHODS THAT WERE USED TO EVALUATE THE TWO TECHNOLOGIES 4. RESULTS OF THE TESTS 5. SELECTION OF ALUMINA AS THE PREFERRED TREATMENT 6. CONCEPTUAL DESIGN 7. COSTS.				
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LITIGATION TECHNICAL SUPPORT AND SERVICES

Rocky Mountain Arsenal

Building 1727 Sump Interim Response Action Assessment

Draft Final Treatability Study

July 1987

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Sump 1727 Water Samples
Collected in February 1987

1.0 INTRODUCTION

In the past 2 years, water has collected in Sump 1727 as a result of possible ground water infiltration, inflow of stormwater runoff, and leakage of water lines in the North Plants area. Ground water infiltration could possibly enter the sump directly through cracks and holes which may exist in the bottom and walls of the sump, into basements of buildings in the North Plants area which drain to Sump 1727, or into underground pipelines which lead to Sump 1727. Stormwater runoff inflow could possibly enter the sump from diked storage areas in the North Plants area which drain to the sump if shutoff valves in the lines leading from these areas to the sump are leaking.

In January 1987, potable water lines in Building 1501 in the GB plant broke as a result of freezing temperatures, and the water that leaked into the basement was subsequently pumped into Sump 1727, nearly filling it. In response to the near overflow condition of the sump over 25,000 gallons of water has been pumped from the sump into tanks and tanker trailers located nearby to the sump.

In February 1987, samples of the sump water were collected for analysis, and the analytical results indicated that the water was contaminated with arsenic, cadmium, lead, fluoride, and isopropylmethylphosphonate (IMPA). As an interim solution to the problem of water continuing to collect in Sump 1727, resulting from possible ground water infiltration and leakage of water lines in the North Plants area, the treatment of the water with discharge to the Rocky Mountain Arsenal (RMA) sanitary sewer was proposed. In support of the proposed

interim solution, a literature review of applicable treatment technologies for removal of arsenic, cadmium, fluoride, and lead was performed. IMPA was not addressed in the literature review because previous North Boundary ground water treatability data reportedly indicates that IMPA is amenable to carbon adsorption treatment, and the RMA sanitary wastewater treatment system provides such treatment.

Based on the literature review, electrochemical precipitation and activated alumina adsorption were found to be the most promising technologies in providing the degree of treatment necessary to allow discharge of the treated water to the RMA sanitary sewer at low to moderate operating costs. Section 2.0 of this report provides additional information concerning the raw water characteristics and identifies the proposed treatment levels for discharge to the RMA sanitary sewer. Section 3.0 describes the treatability test methods that were used to evaluate electrochemical precipitation and activated alumina adsorption test units, and the test results are discussed in Section 4.0. Selection of the preferred treatment technology is discussed in Section 5.0, which also presents the conceptual design and estimated costs (capital, and operations and maintenance) for the preferred technology.

2.0 RAW WATER CHARACTERISTICS, PROPOSED TREATMENT LEVELS, AND TREATMENT TECHNOLOGY ELECTION

2.1 RAW WATER CHARACTERISTICS

In February 1987, samples of water were collected from Sump 1727 and analyzed by EBASCO and RMA Analytical Laboratory for the analytes listed in Table 2.1-1. The analytical results indicated arsenic, cadmium, lead, fluoride, and isopropyl-methylphosphonate (IMPA) were present at elevated concentrations. Arsenic was detected at 17.8 parts per million (ppm), cadmium was detected at 0.551 ppm, lead was detected at 0.250 ppm, fluoride was detected at 12.4 ppm, and IMPA was detected at 19 ppm. The pH of the water was 10.1. Target volatile and semivolatile organics were below detection limits and the rest of the heavy metals (chromium, copper, mercury, and zinc) were either below National Primary Drinking Water Standard maximum contaminant levels (MCLs) or below detection limits. Chloride, potassium, and sodium were the only other analytes detected. Appendix A contains all of the analytical results.

Arsenic, cadmium, fluoride, and lead were selected as the contaminants of concern for subsequent treatability testing because the concentrations detected for each of these contaminants exceeded their respective National Primary Drinking Water Standard MCLs. IMPA was not selected as a contaminant of concern for treatability testing at this time because previous North Boundary ground water treatability data reportedly indicates that IMPA is amenable to activated carbon adsorption treatment, and the RMA sanitary wastewater treatment system provides such treatment.

Table 2.1-1. Analytes for Sump 1727 Water Samples
Collected in February 1987

Semi-Volatiles:

Aldrin
Atrazine
Chlordane
Hexachlorocyclopentadiene
P-Chlorophenylmethylsulfide
P-Chlorophenylmethylsulfoxide
P-Chlorophenylmethylsulfone
Dibromochloropropane
Dicyclopentadiene
Vapona (DDVP)
Diisopropylmethylphosphonate
Dithiane
Dieldrin
Dimethylmethylphosphonate
Endrin
Isodrin
Malathion
Oxathiane
P,P-DDE
P,P-DDT
Parathion
Supona

Metals:

Cadmium
Calcium
Chromium
Copper
Lead
Magnesium
Mercury
Potassium
Sodium
Zinc

Others:

Chloride
Fluoride
Dichlorobromopropane

Agent Screening:

GB
HD

Volatiles:

Bicycloheptadiene
Carbon tetrachloride
Chloroform
Dichloromethane
Chlorobenzene
Benzene
Dibromochloropropane
Dicyclopentadiene
Dimethyldisulfide
Ethylbenzene
Toluene
Methyisobutylketone
Tetrachloroethylene
Trichloroethylene

1,2-Dichloroethylene
Xylene
1,1-Dichloroethane
1,1,1,-Trichloroethane
1,1,2-Trichloroethane
1,2-Dichloroethane
1,3-Dimethylbenzene

2.2 PROPOSED TREATMENT LEVELS

Under the National Primary Drinking Water Regulations, MCLs in potable water supplies have been established for ten inorganic chemicals. MCLs for the contaminants of concern as set forth in 40 CFR 141.11 are presented in Table 2.2-1, which also presents the concentration detected in the Sump 1727 water samples collected in February 1987.

To minimize any potentially adverse impact to the operation of the RMA sanitary wastewater treatment system and the system's effluent quality, the National Primary Drinking Water MCLs shown in Table 2.2-1 were selected as the treatment levels for the treatability testing.

2.3 TREATMENT TECHNOLOGY SELECTION

In order to select appropriate treatment technologies for treatability testing, a brief literature search was performed and commercial vendors of potentially applicable package treatment systems were contacted to gather information pertaining to the expected treatment efficiencies for the contaminants of concern, as well as the installation and operational requirements of the various types of treatment. As a result of this effort, two candidate treatment technologies were identified: 1) electrochemical precipitation; and 2) activated alumina adsorption. Although electrochemical precipitation was identified as a technology potentially capable of removing all of the contaminants of concern,

Table 2.2-1. National Primary Drinking Water Regulations for
the Contaminants of Concern

<u>Contaminant</u>	<u>Maximum Contaminant Milligrams Per Liter</u>	<u>Detected Concentration, Milligrams Per Liter</u>
Arsenic	0.05	17.8
Cadmium	0.010	0.551
Lead	0.05	0.250
Fluoride	4.0	12.4

activated alumina adsorption was identified as an especially effective technology for arsenic and fluoride removal. If the treatability testing of the activated alumina adsorption verified its effectiveness for arsenic and fluoride removal, consideration would then be given to combining this technology with a proven cadmium and lead removal technology.

Information obtained from a commercial vendor on an electrochemical precipitation package treatment unit with a capacity large enough to treat the water in Sump 1727 (80,000 gallons) over a period of approximately 2 months indicated that the unit could be shipped, installed, and leased for 2 months for a cost of about \$15,000. Installation would be relatively simple requiring conventional power hookup, and plumbing from the sump to the unit and from the unit to the point of discharge. Operational requirements would include approximately 2 to 4 hours per day of operator labor to attend to chemical addition equipment; and removal, containerizing, and shipment of sludge generated by the treatment unit to a secure disposal facility. An estimated 10,000 gallons of sludge with a solids content of 2 to 3 percent by weight would be generated by the treatment of 80,000 gallons of sump water.

Based on existing ESE project file information, the estimated capital cost for an activated alumina system with a design capacity of approximately 2,500 gallons per day is about \$20,000. Operator labor requirements would be similar to the electrochemical precipitation system, and would also include routine replacement of the spent alumina. The total volume of spent alumina that would have to be disposed of as a hazardous waste is estimated to be about 75 cubic feet. Regeneration of the alumina rather than disposing of it would be less cost

effective because of the increased operational requirement and cost of treating and disposing of the spent regenerant solution.

As shown above, the cost of leasing a commercially available electrochemical precipitation system compares favorably with the capital cost of an activated alumina system, and both costs are relatively low treatment technology costs. Similarly, the operational requirements are relatively minor.

Consequently, an electrochemical precipitation package treatment system (supplied by Andco Environmental Processes, Inc.) was selected for treatability testing and two activated alumina adsorption test columns were fabricated for testing. The testing of these two technologies is described in the following sections.

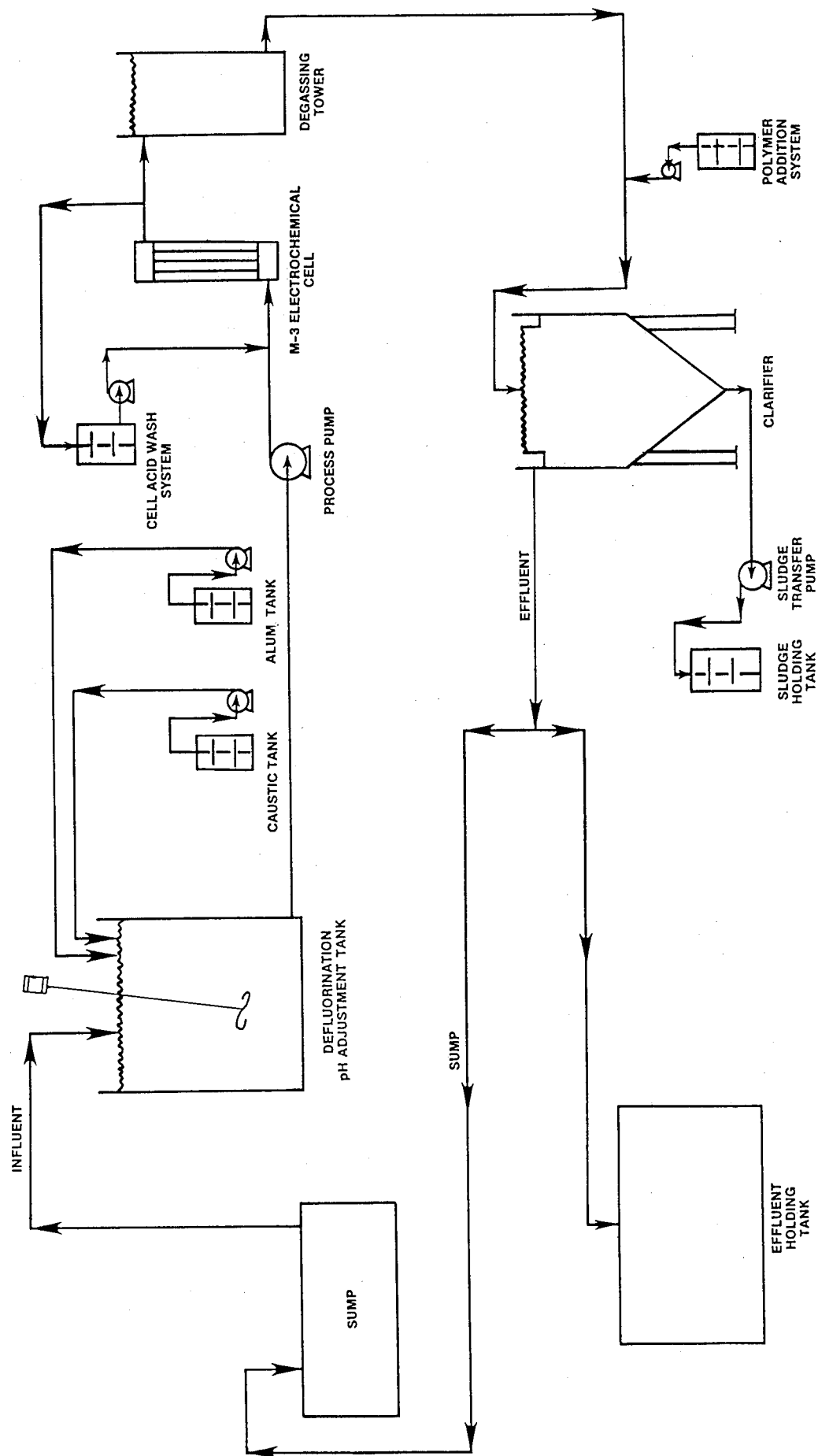
3.0 TREATABILITY TEST METHODS

3.1 ELECTROCHEMICAL PRECIPITATION

3.1.1 Description of Unit and Process

The Andco electrochemical precipitation package treatment system utilizes chemical addition with an electrochemical process to precipitate heavy metals, fluoride, and arsenic from solution. A schematic diagram of the treatment system tested is shown in Figure 3.1-1. As shown in Figure 3.1-1, water was pumped from Sump 1727 to the defluorination/pH adjustment tank for alum addition and pH adjustment by addition of caustic. The alum was added for arsenic and fluoride removal, and the pH adjustment facilitated the electrochemical precipitation of metals from solution.

From the pH adjustment tank the water was pumped through the electrochemical cell where ferrous hydroxide precipitate was produced. Inside the cell there were three, equally spaced, cold rolled 1/8-inch thick steel plates between which the wastewater flowed, hence the name M-3 cell. A direct current (DC) power supply was connected across the end plates turning the plates into electrodes. As the current flowed from electrode to electrode, it caused the anode to dissolve, introducing ferrous hydroxide ions and hydrogen gas bubbles into the wastewater flowing between the plates. The ferrous hydroxide, which is the useful product of the reaction, promoted the precipitation of the metals from solution. The hydrogen gas, on the other hand, served no useful purpose for treatment.



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 For Rocky Mountain Arsenal
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Figure 3.1-1
 PROCESS FLOW DIAGRAM-ELECTROCHEMICAL UNIT

From the electrochemical cell, the water flowed to a degassing tower. This was an open-top tank which allowed sufficient time for the release of the hydrogen gas bubbles, which if not removed, would interfere with settling of the ferrous hydroxide floc in the clarifier. From the degassing tower the water flowed to the clarifier which allowed the precipitated metals to settle.

An anionic polymer was added in line to the clarifier influent as a flocculent aid to promote settling of the floc. The precipitated metals settled to the bottom of the clarifier forming a sludge with a solids content of 1 to 2 percent by weight. The clarifier supernatant was then returned to Sump 1727.

The acid wash system shown in the schematic design was used to recirculate a sulfuric acid solution through the cell to prevent the buildup of scale and sludge on the electrodes which would have an adverse effect on the electrochemical reaction. The acid wash is normally done after every 24 hours of operation.

3.1.2 Testing Methodology and Conditions

Samples of effluent were collected approximately every half hour, while samples of influent were collected approximately every hour over a four hour period. Two 1-liter fractions were taken at each sample location, one for metals analysis and the other for fluoride analysis. The metals sample fractions were pH adjusted with nitric acid to a pH of 2 or less. The samples were then packed on ice in coolers for delivery to ESE's laboratory.

Each sample was analyzed for arsenic, fluoride, cadmium, and lead. The analytical methods used for these contaminants were the EPA (1983) "Methods for Chemical Analysis of Water and Wastes." The methods used for arsenic, fluoride, cadmium, and lead were 206.2, 300, 213.2, and 239.2, respectively.

Operating conditions for the unit were as follows. The sump water was pumped into the defluorination/pH adjustment tank at a rate of 4.1 gallons per minute (gpm) and exited at 4.5 gpm (a result of differences in pumping rates in and out of the tank). In the defluorination/pH adjustment tank, alum was added at an aluminum to fluoride ratio of approximately 5.2 to 1. This dropped the pH of the solution from 10 to slightly below 7. A solution of sodium carbonate was added to raise the pH to between 7 and 8. The M-3 cell was set to 10 amperes producing an iron concentration in the stream exiting the cell of 30.6 ppm. This water was rusty in color indicating that the ferrous ion had oxidized to the ferric state. The polymer which was added prior to the clarifier consisted of a polyamide in an oil emulsion. It was added at rate of 3.8 gallons per day (gpd) through an ejector valve.

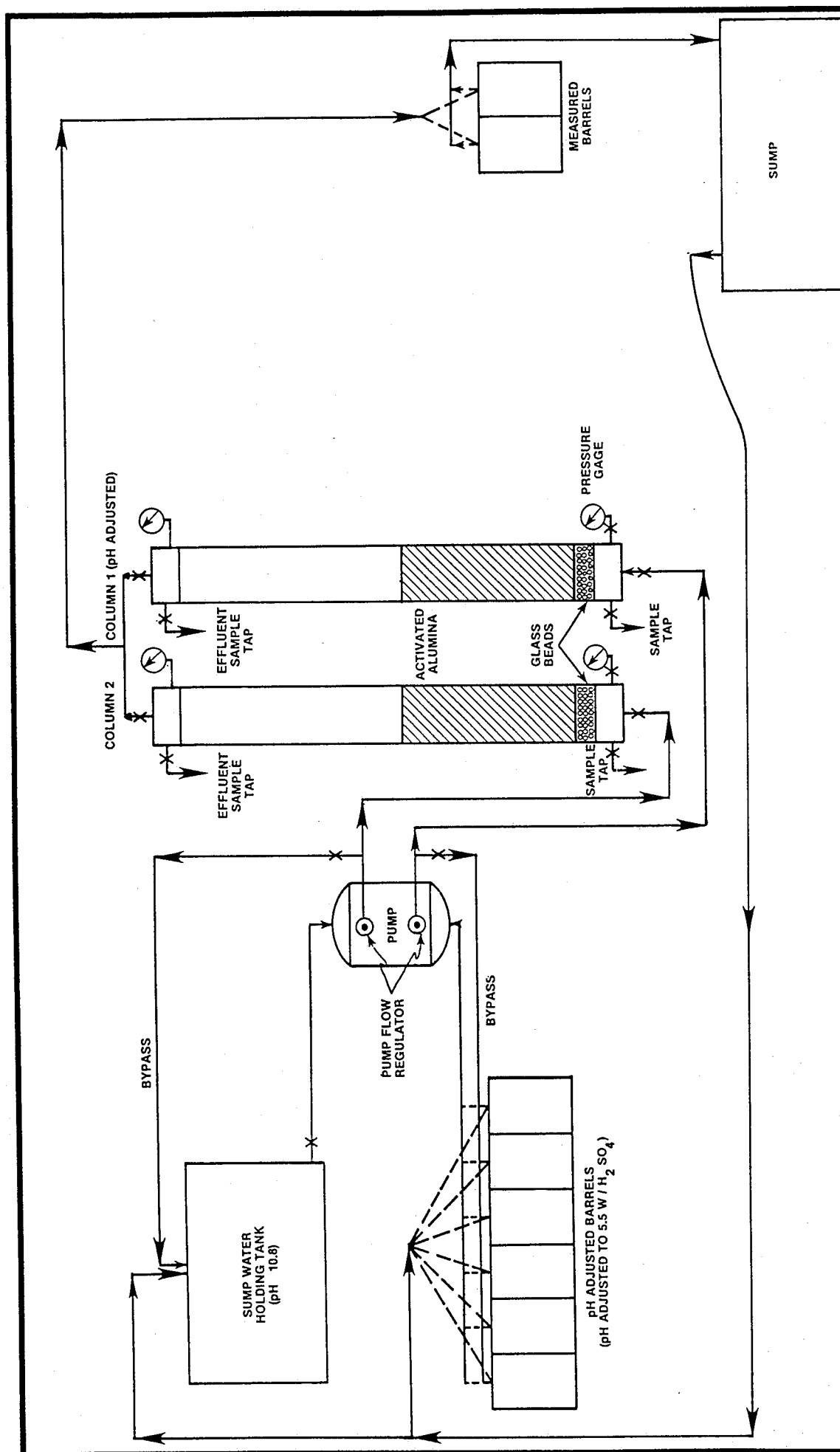
3.2 ACTIVATED ALUMINA ADSORPTION

3.2.1 Description of Unit and Process

Activated alumina has been proven to be an effective method of reducing fluoride and arsenic in waste and ground water (Rubel and Woosley, 1979; Rubel and Hathaway, 1985; EPA, 1984; Prusinski, RMA 1978; Thompson, Terkonda, Streebin, 1980; Rubel, Hager 1980; Rubel, Hager 1978). Some of the factors affecting adsorption of arsenic and fluoride to activated alumina are pH, fluoride, and arsenic concentrations; type and size of activated alumina; and bed contact time. The optimum pH for fluoride and arsenic removal is 5.5 (Rubel and Woosley, 1979); however, at this optimum pH, arsenic is preferentially adsorbed over fluoride (EPA, 1984).

The activated alumina test apparatus was designed to treat two separate water supplies (see Figure 3.2-1). The apparatus included a group of six barrels for one water supply and a large holding tank for the other. Water was pumped directly from the sump into either the barrels or the tank. Sulfuric acid was added to the sump water in the barrels to adjust the pH to an optimum of 5.5 ± 0.2 . The pH of the sump water in the holding tank (approximately pH 10) was not adjusted. Water was pumped from the barrels and tank by a positive pressure diaphragm pump to Columns 1 and 2, respectively. Flow regulators for each column were located at the top of the pump to control the flow into each of the columns.

The columns were 4 inches in diameter and 6 feet tall. They were run in an up-flow mode with a 10 minute bed contact time. Up-flow was used to prevent compacting or cementing effects on the treatment bed. It also ensured a consistent media contact



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Figure 3.2-1
 ACTIVATED ALUMINA PROCESS DIAGRAM

time and reduced channeling. The bed depth was approximately 2 feet. Glass beads were used in the columns to keep the activated alumina from backing into the fittings and to help distribute an even flow through the columns. The type of media used in the columns was the Alcoa F-1 mesh size 14-28 activated alumina. Detailed design and operating conditions of the two columns are summarized in Table 3.2-1.

Pressure gages were located at the top and bottom of the columns. The gages were monitored closely for any indication of a problem such as clogging or cementing.

The effluent water leaving the columns was directed to barrels that measured the amount of effluent. From these barrels, the water was pumped back into the sump.

3.2.2 Testing Methodology and Conditions

Influent and effluent samples were taken at a frequency of approximately every 7.5 bed volumes or every hour and 15 minutes. Samples were taken when the effluent barrel measuring the volume from the columns indicated 20 total gallons (10 from each column) of treated water.

Samples of influent and effluent were taken at the locations indicated in Figure 3.2-1. However, starting from the thirteenth sample, the influent samples were taken from the bypass. The influent sampling location was changed because it was determined that the water being sampled from the influent sample taps had likely contacted the column media because the flow rates were not sufficient to sample at this location without drawing water down the column from the media bed.

Table 3.2-1. Column Design and Operating Conditions

	Column 1 (pH adjusted)	Column 2
Height of Column (feet)	6	6
Diameter of Column (inches)	4	4
Treatment Bed Depth (inches)	24	25½
Treatment Bed Volume	0.175ft ³ (1.305 gal)	0.184ft ³ (1.374 gal)
Specific Weight of A.A.*	52 lb/ft ³	52 lb/ft ³
Weight of A.A. (pounds)	9.1	9.0
Treated Water Flow Rate	0.1305 gal/min (494 ml/min)	0.1374 gal/min (520 ml/min)
Bed Contact Time (minutes)	10	10
Approximate Sampling Frequency	1 hr 15 min 10 gal 7.5 bed volumes	1 hr 15 min 10 gal 7.5 bed volumes
Number of Sampling Periods	73	73
Approximate Total Amount of Water Processed (gallons)	710	710

*A.A. = Activated alumina, F-1 14-28 mesh size.

Source: ESE, 1987.

Effluent samples were always taken before influent samples to prevent sampling that could be affected by pulsing or mixing effects in the column. Two 1-liter fractions were taken at each sample location one for metals analysis and the other for fluoride analysis. Sample fractions taken for metals were pH adjusted with nitric acid to a pH of two or less. Samples were then packed on ice in coolers for delivery to ESE's laboratory. Prior to sampling each effluent, a flow rate was taken by filling a graduated cylinder over a 1-minute time period.

A colorimeter field test was performed on each sample (influent and effluent of each column) to determine the amount of fluoride in that sample. This data was used as a field check to determine if fluoride breakthrough had occurred. Fluoride breakthrough was expected to occur first because arsenic adsorbs more readily than fluoride at the same optimum pH.

Sampling was continued until a clear breakthrough was indicated by either the colorimeter test or laboratory analyses.

The date, sample number, sample times, flow rates, total amount of water processed, pressure at influent, fluoride concentration, and column conditions were all recorded on the field log sheets. Changes in the system, operation of the system, and column media were recorded in the field log book.

Each sample was analyzed for arsenic, fluoride, cadmium, and lead. The analytical methods used for these contaminants were

from the EPA (1983) "Methods for Chemical Analysis of Water and Wastes". The methods used for arsenic, fluoride, cadmium, and lead were 206.2, 300, 213.2, and 239.2, respectively.

4.0 TEST RESULTS

4.1 ELECTROCHEMICAL PRECIPITATION

The treatability test results for the electrochemical precipitation treatment system are presented in Table 4.1-1, and the average influent and effluent concentrations are as follows:

	Influent (ug/L)	Effluent (ug/L)	MCL (ug/L)
F	13,600	5,556	4,000
As	11,233	116	50
Cd	1.5	0.5	10
Pb	24.1	3.1	50

The treatment efficiencies for fluoride, arsenic, cadmium, and lead removal were 59.1, 99.0, 66, and 87.1 percent, respectively. Although these removal percentages were high, the effluent contaminant levels exceeded the proposed MCL treatment levels for arsenic and fluoride. A fine floc visually apparent in the clarifier effluent was most likely the cause of the elevated levels of fluoride and arsenic in the effluent. The influent data for cadmium and lead shows that the concentrations are below the Primary Drinking Water Standard MCLs for these metals, a substantial reduction from the cadmium and lead levels detected in the sump water samples collected in February 1987. This reduction could possibly have resulted from settling of suspended solids that may have been the source of the metals contamination, or dilution by uncontaminated inflow to the sump since February 1987.

Table 4.1-1. Treatability Test Results for
Electrochemical Precipitation System

	Concentration (ug/L)			
	<u>Arsenic</u>	<u>Cadmium</u>	<u>Fluoride</u>	<u>Lead</u>
Influent	10,800	3.2	13,600	23.6
	11,200	0.6	13,600	24.6
	11,700	0.6	13,600	24.2
Effluent	99.2	0.4	4,940	3.5
	98.6	0.6	6,270	5.1
	156	0.6	5,390	1.6
	169	0.6	5,610	3.3
	171	0.3	5,570	2.7
	10.4	0.4	5,600	2.2

4.2 ACTIVATED ALUMINA

The treatability test results (average influent and effluent concentrations) for the activated alumina adsorption system are presented in Table 4.2-1. As expected, Column 1 (pH adjusted) performed much better than Column 2 (non-pH adjusted), and the treatment efficiencies for Column 1 for arsenic, cadmium, lead, and fluoride removal were 99.9, 27.8, 67.3, and 64.0, respectively. All of the contaminants of concern in the Column 1 effluent were below the MCLs, except for fluoride which slightly exceeded the MCL. The effluent data for Column 2 indicates that both the arsenic and fluoride concentrations were considerably above the MCLs.

Similar to the influent cadmium and lead concentrations for the electrochemical precipitation test, the influent cadmium and lead concentrations for the activated alumina test columns were below the MCLs. Column 1 treated 161 bed volumes (210 gallons) of water to an arsenic concentration of less than 20 ug/L or parts per billion (ppb). Starting from bed volume #168 (220 gallons), the arsenic concentrations of the effluent water increased to 418 ppb and continued to increase as more water was processed. Fluoride was not adsorbed as readily as arsenic in Column 1. The results indicate that fluoride concentrations in the effluent water ranged from 4,020 to 4,540 ppb for the first 153 bed volumes (200 gallons). Again, as more water was processed the fluoride concentrations in the effluent increased. Arsenic and fluoride breakthrough curves for Column 1 effluent are presented in Figures 4.2-1 and 4.2-2, respectively. Influent arsenic and fluoride concentrations for Column 1 were plotted in Figures 4.2-3 and 4.2-4, respectively. For Column 2, the arsenic and fluoride

breakthrough curves are presented in Figures 4.2-5 and 4.2-6, respectively, and the influent arsenic and fluoride levels are plotted in Figures 4.2-7 and 4.2-8, respectively.

Table 4.2-1. Treatability Test Results for
Activated Alumina Adsorption System

Average Concentration (ug/L)					
	Column 1		Column 2		
	pH Adjusted*		Non-pH Adjusted**		
	<u>Influent</u>	<u>Effluent</u>	<u>Influent</u>	<u>Effluent</u>	<u>MCL</u>
Arsenic	11,830	17.2	11,970	5,250	50
Cadmium	1.8	1.3	0.8	1.0	10
Lead	20.2	6.6	17.9	5.5	50
Fluoride	11,680	4,210	12,400	11,780	4,000

* pH 5.5 \pm 0.2

** pH 10

As shown in Figures 4.2-9 and 4.2-10, which present the Column 1 effluent and influent cadmium levels, respectively, no significant cadmium removals were effected. Figures 4.2-11 and 4.2-12 present the Column 1 effluent and influent lead levels, respectively. Although these plots indicate erratic effluent lead levels, an average 67.3 percent removal for lead was achieved by Column 1.

The Column 2 effluent and influent cadmium levels shown in Figures 4.2-13 and 4.2-14, respectively, indicate that no significant cadmium removals were achieved. However, a review of Figures 4.2-9 and 4.2-10, which present the Column 2 effluent and influent lead levels, respectively, indicates that except for one sample set, lead was consistently removed. Column 2 achieved an average 67.3 percent treatment efficiency for lead removal.

An event that appears to have affected the data is the change of influent sampling locations. Samples taken from the sample tap at the bottom of the columns indicate reduced concentrations of arsenic and fluoride relative to samples taken at the bypass. This may have been caused by sample contact with the activated alumina. Starting with sample #13, samples were taken at the bypass which gives a more representative influent sample.

It should also be noted that the system was put into a continuous loop for a period of time and some regeneration occurred in the columns. This can be seen in Figures 4.2-1 and 4.2-2 at approximately 650 gallons of processed effluent.

The results from these activated alumina tests indicate that

the pH adjusted system, Column 1, was able to treat the water to all of the proposed treatment levels. Approximately 200 gallons were treated in Column 1 before the concentrations of fluoride and arsenic increased above the proposed treatment levels.

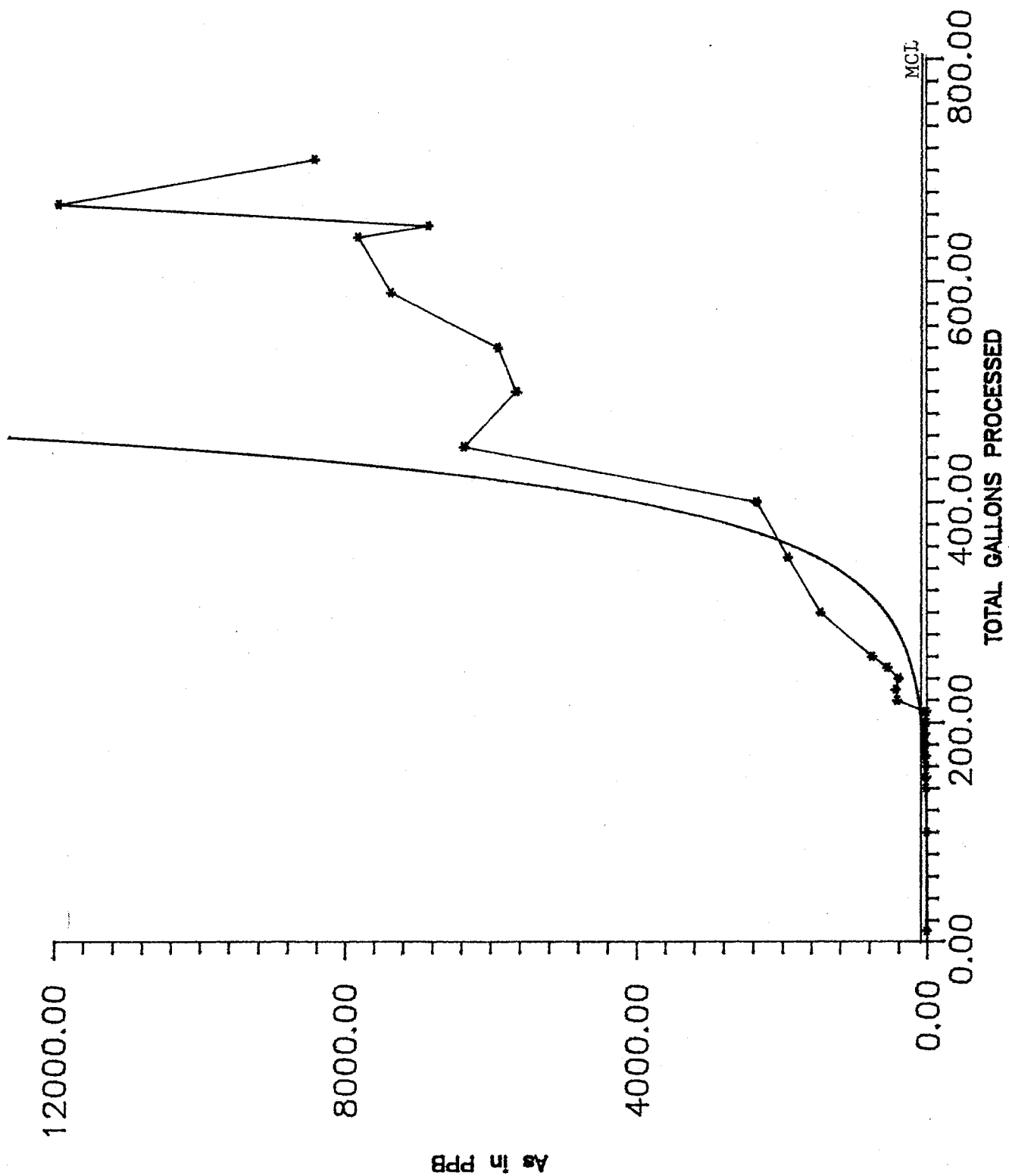


Figure 4.2-1. Plot of Column #1 Effluent, Arsenic Levels

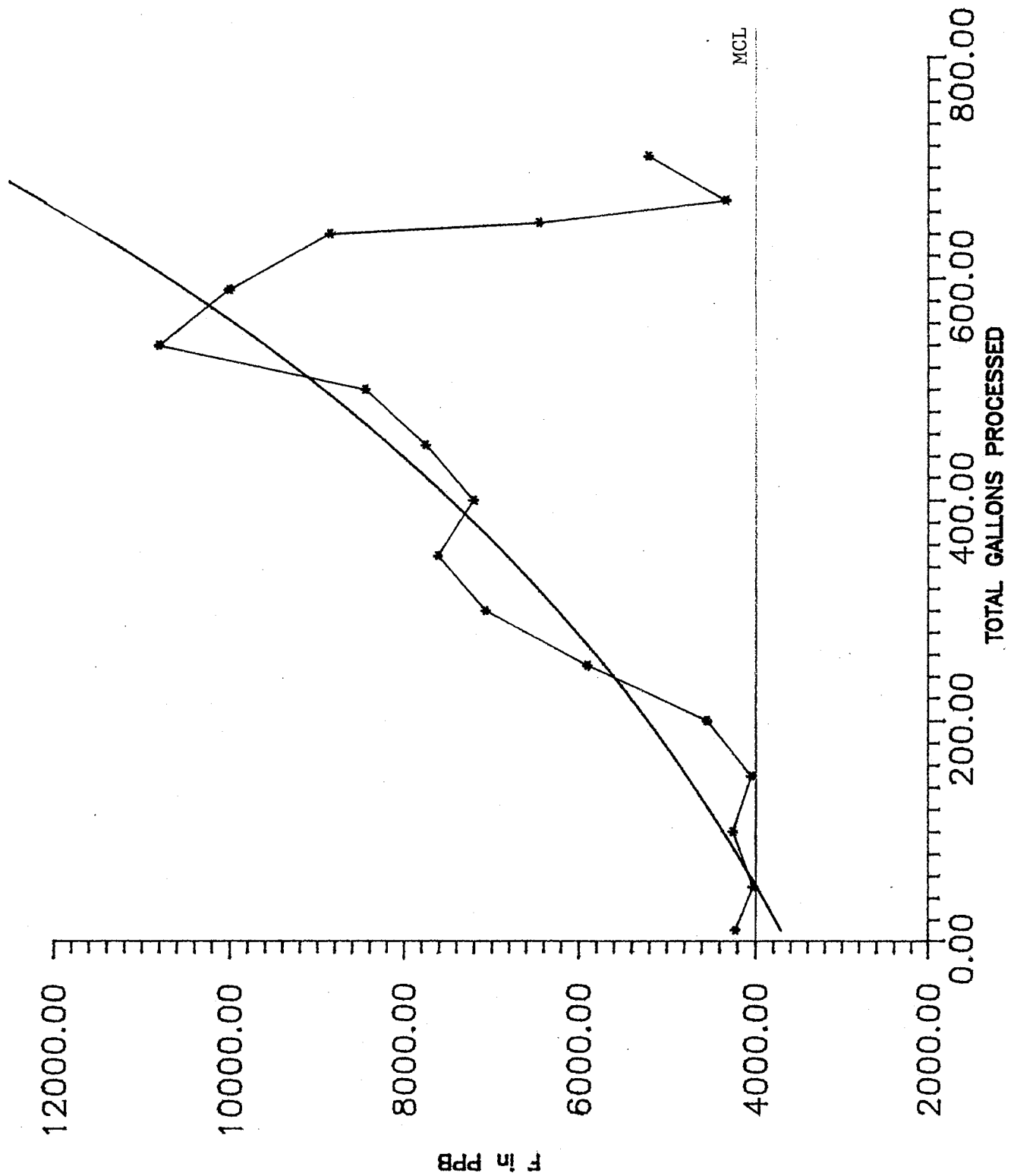


Figure 4.2-2. Plot of Column #1 Effluent, Fluoride Levels

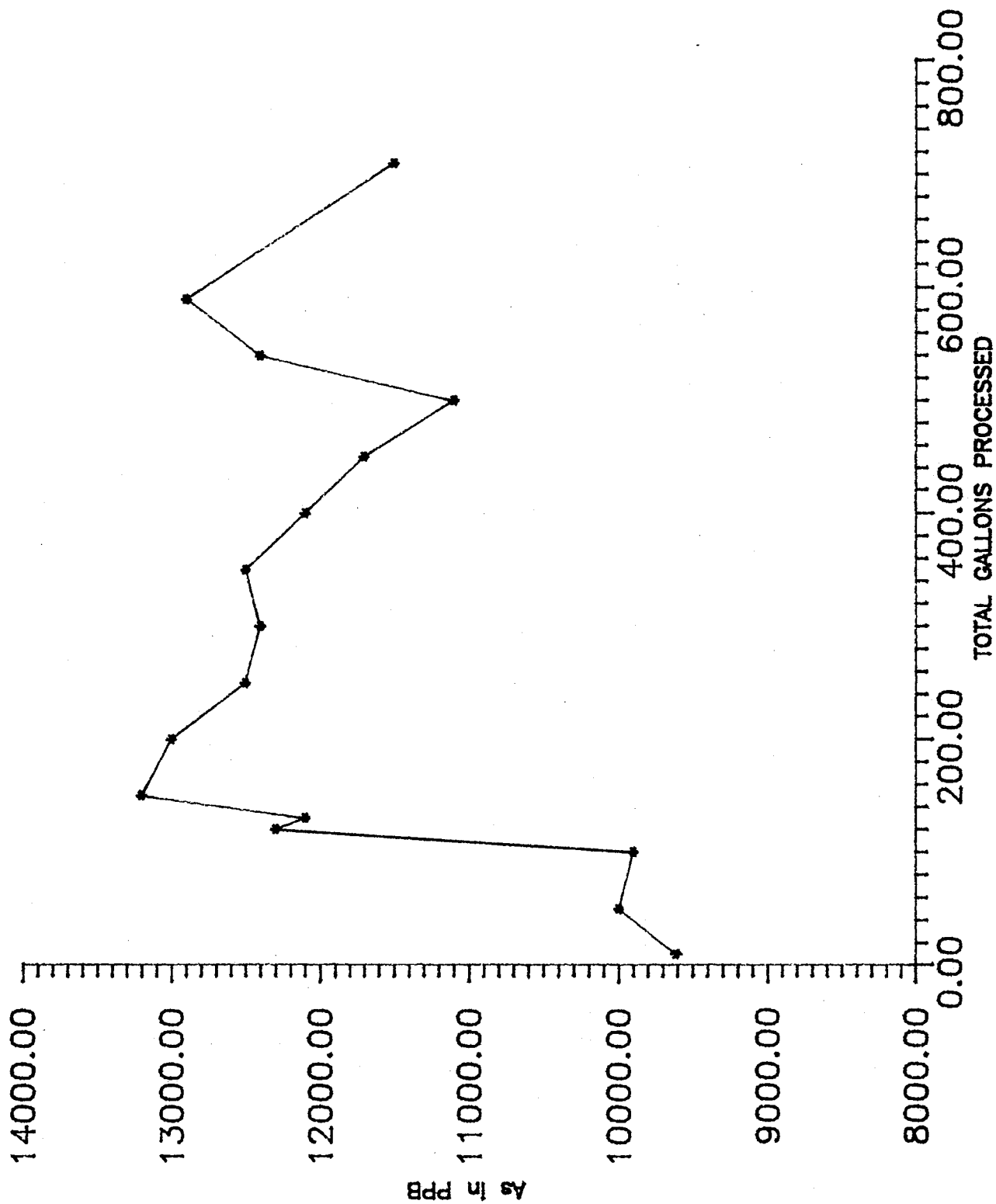


Figure 4.2-3. Plot of Column #1 Influent, Arsenic Levels

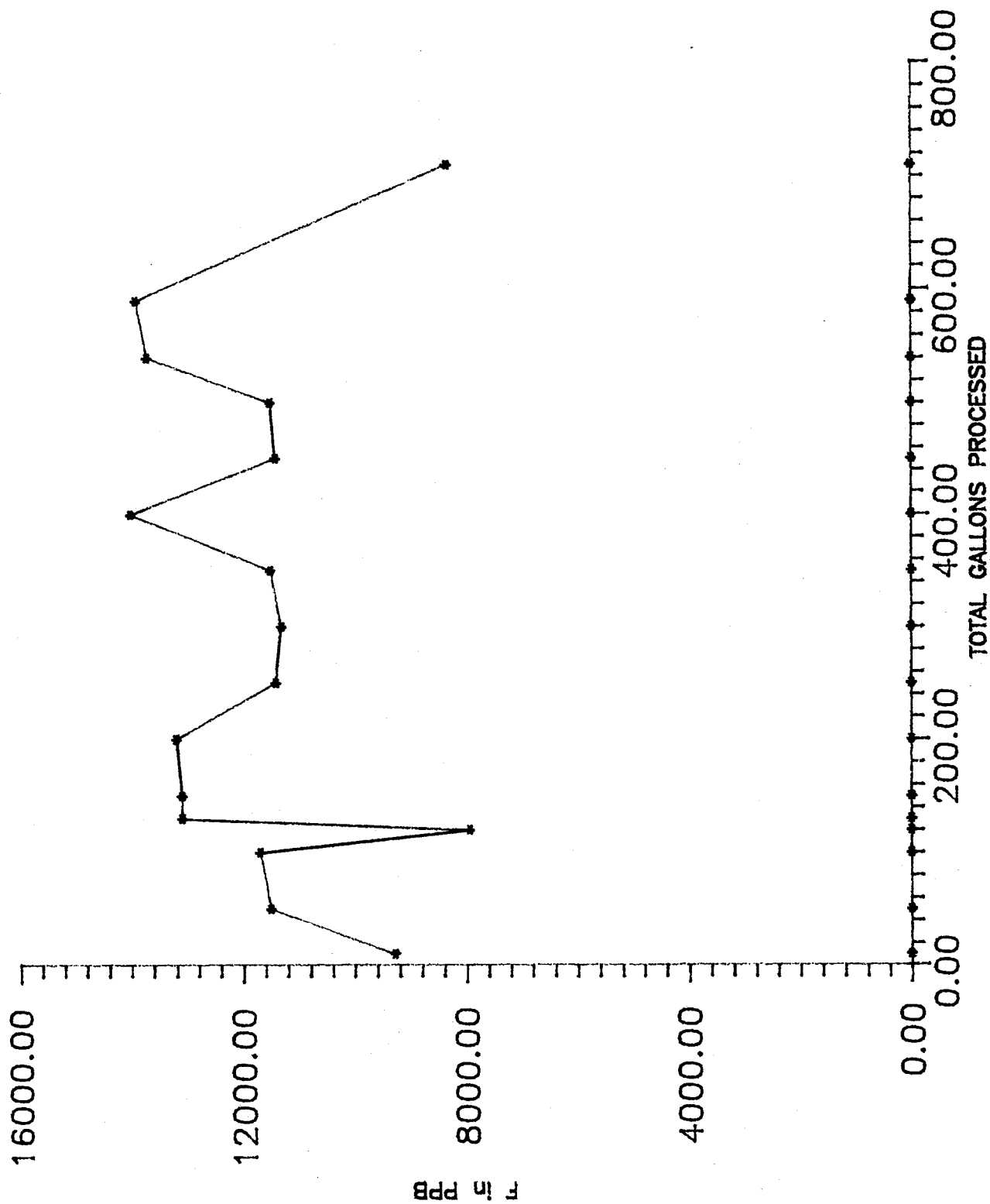


Figure 4.2-4. Plot of Column #1 Influent, Fluoride Levels

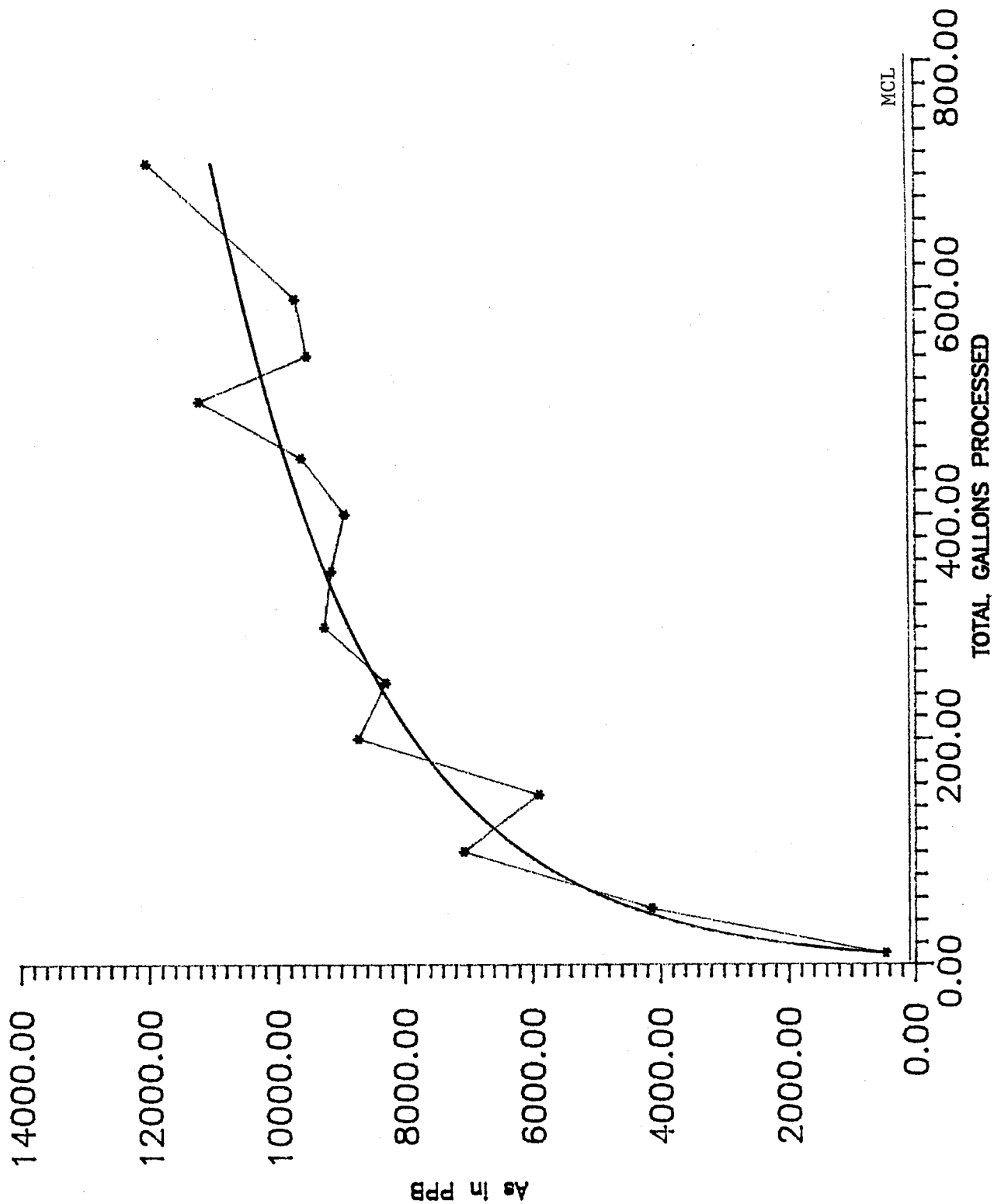


Figure 4.2-5. Plot of Column #2 Effluent, Arsenic Levels

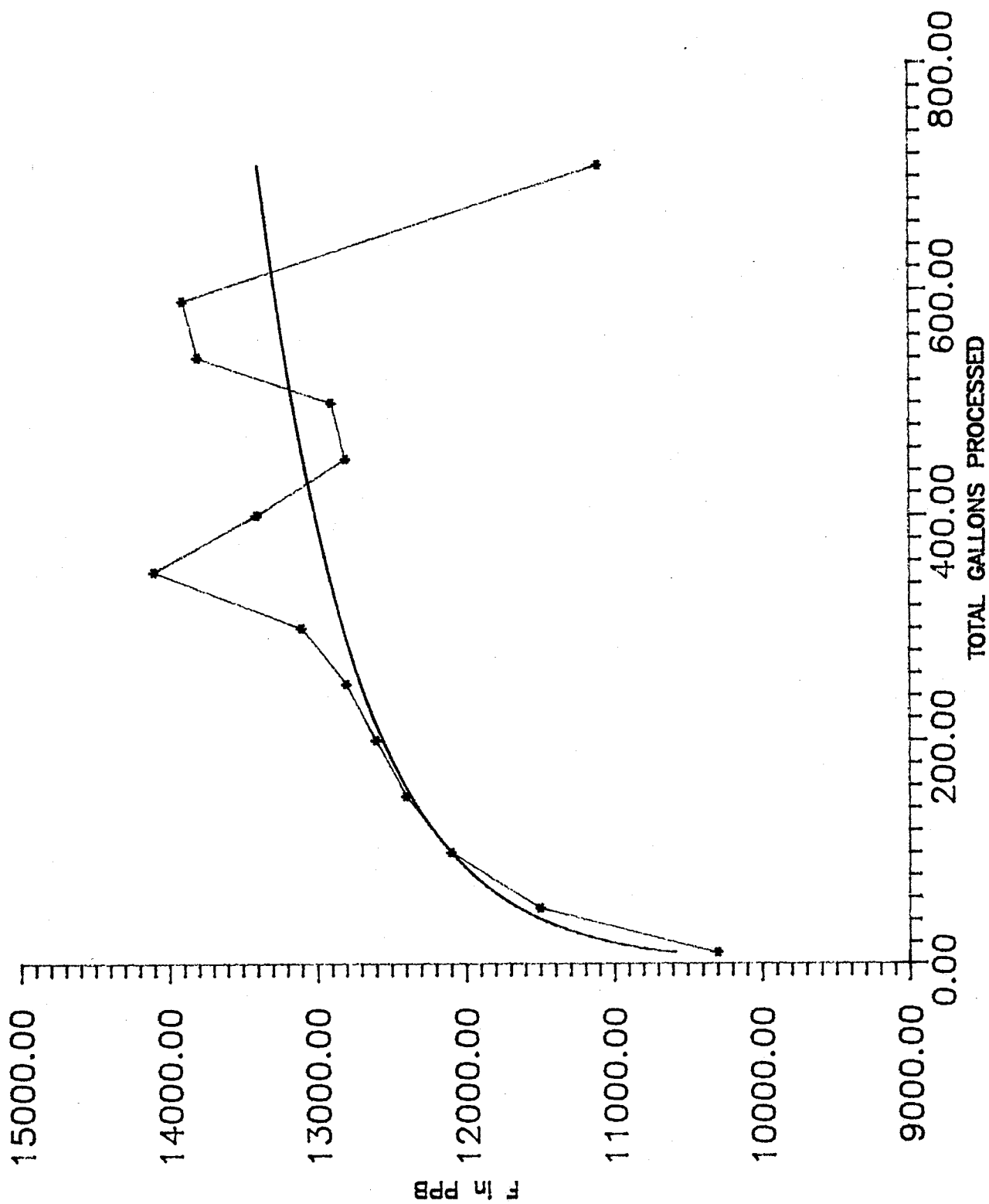


Figure 4.2-6. Plot of Column #2 Effluent, Fluoride Levels

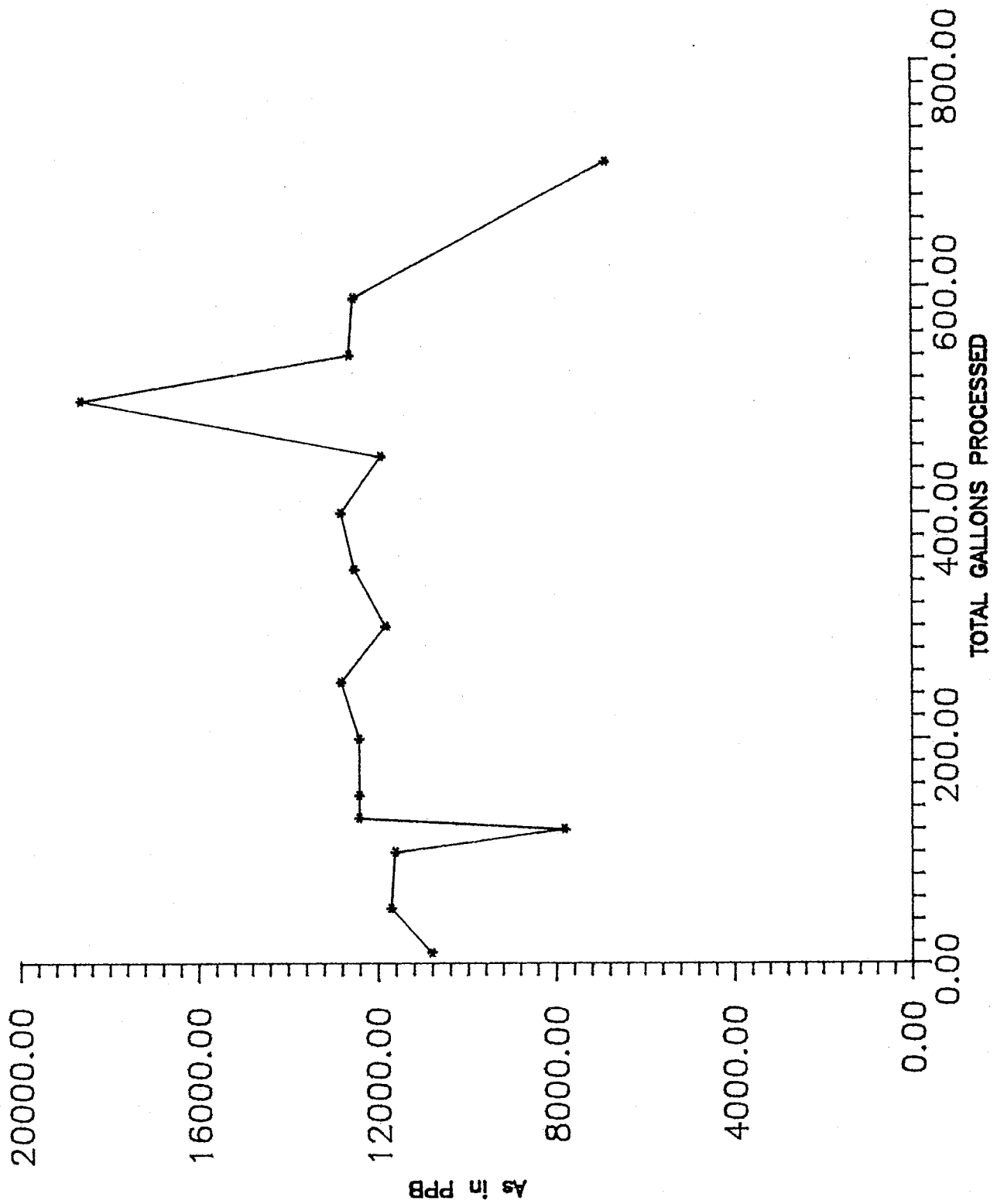


Figure 4.2-7. Plot of Column #2 Influent, Arsenic Levels

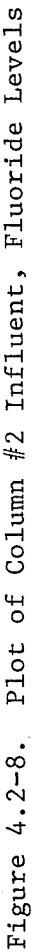


Figure 4.2-8. Plot of Column #2 Influent, Fluoride Levels

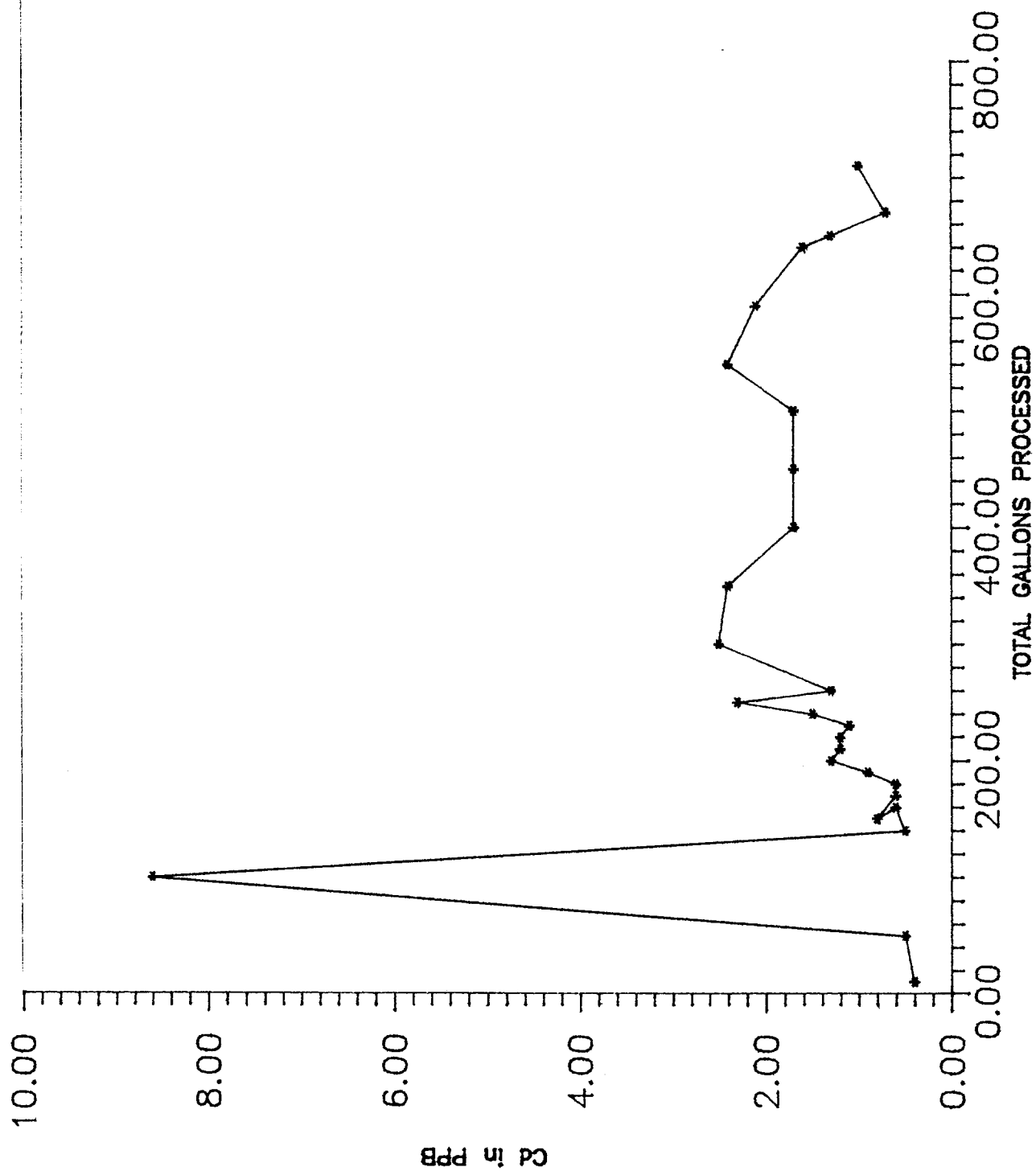


Figure 4.2-9. Plot of Column #1 Effluent, Cadmium Levels

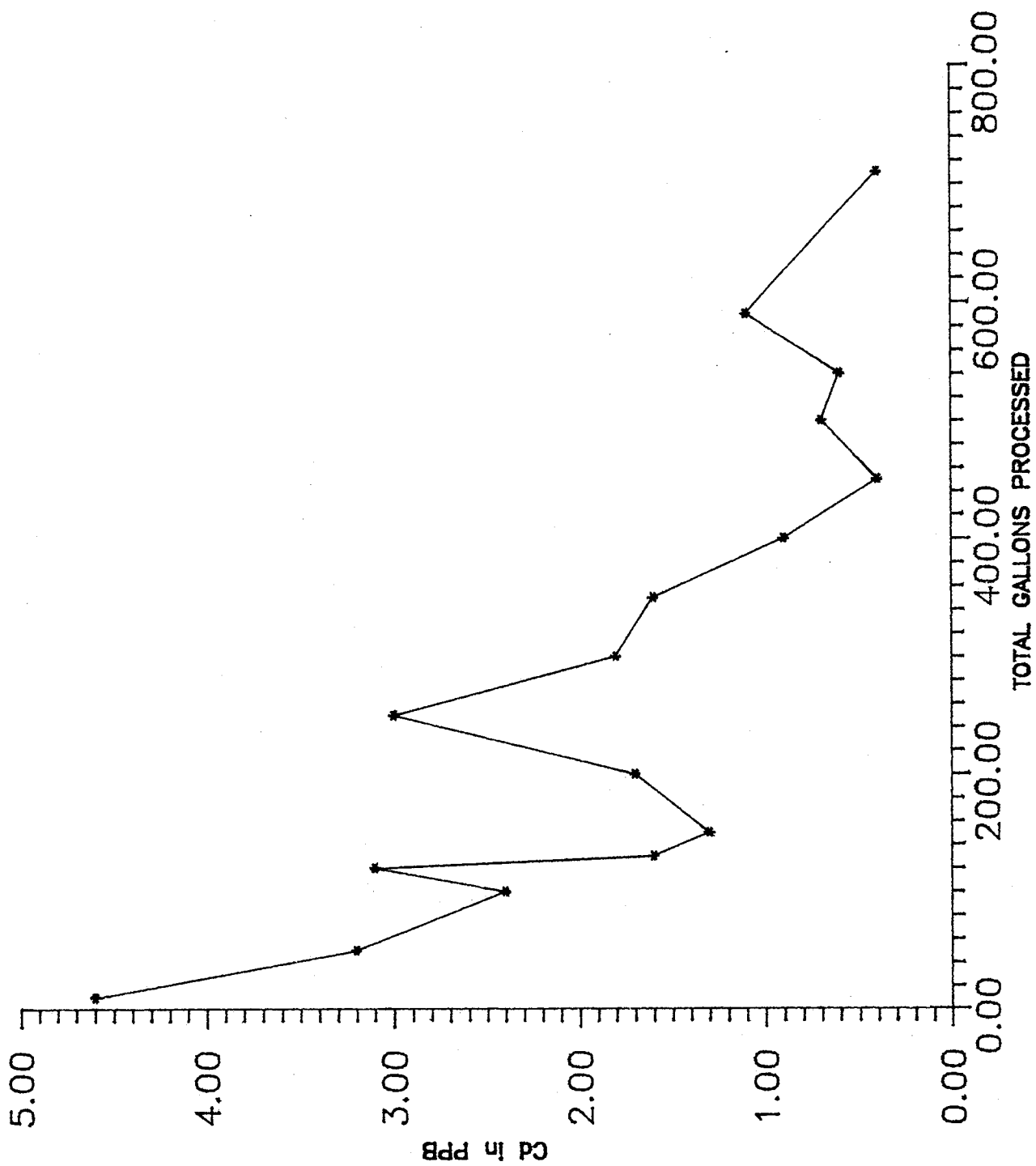


Figure 4.2-10. Plot of Column #1 Influent, Cadmium Levels

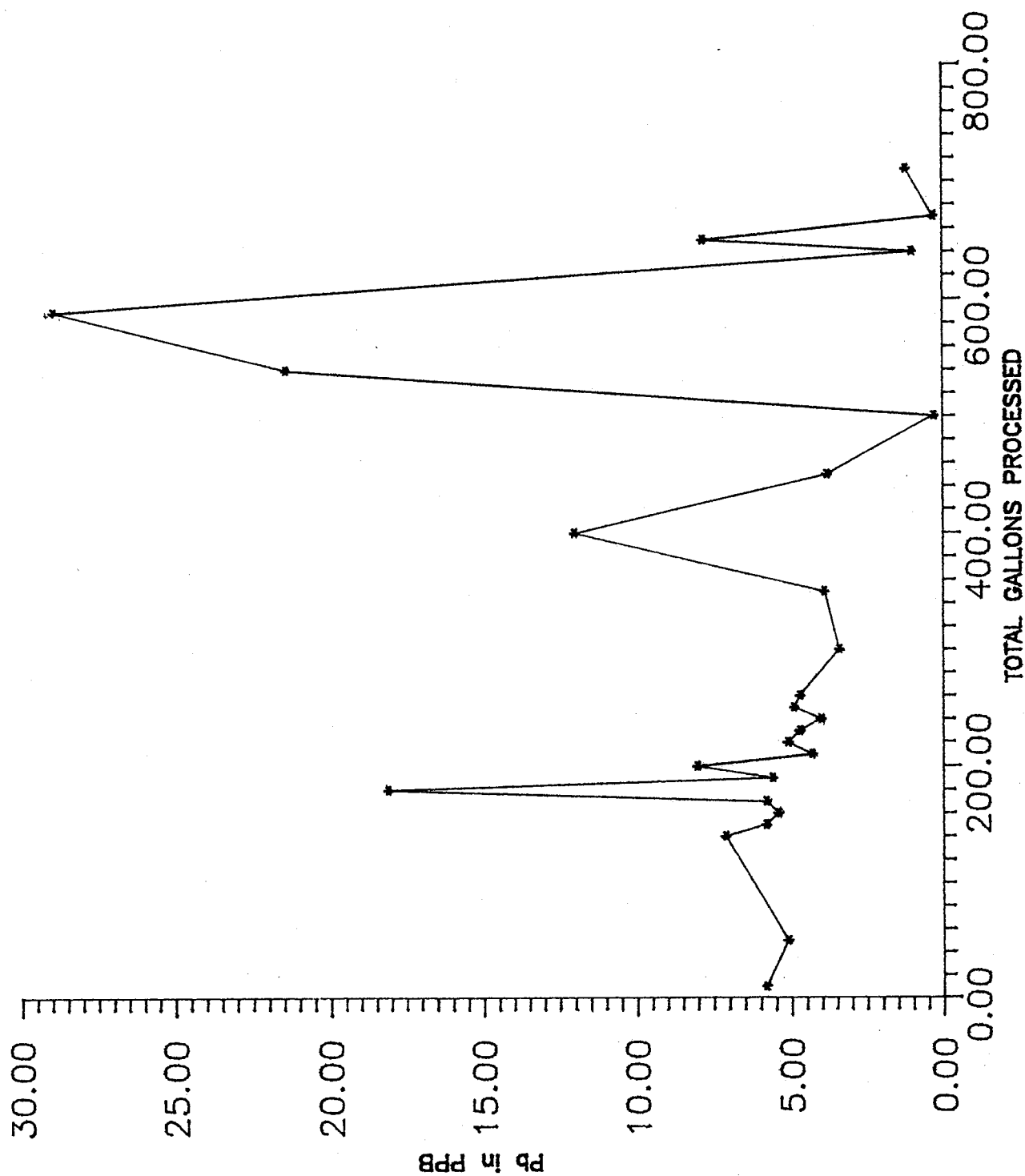


Figure 4.2-11. Plot of Column #1 Effluent, Lead Levels

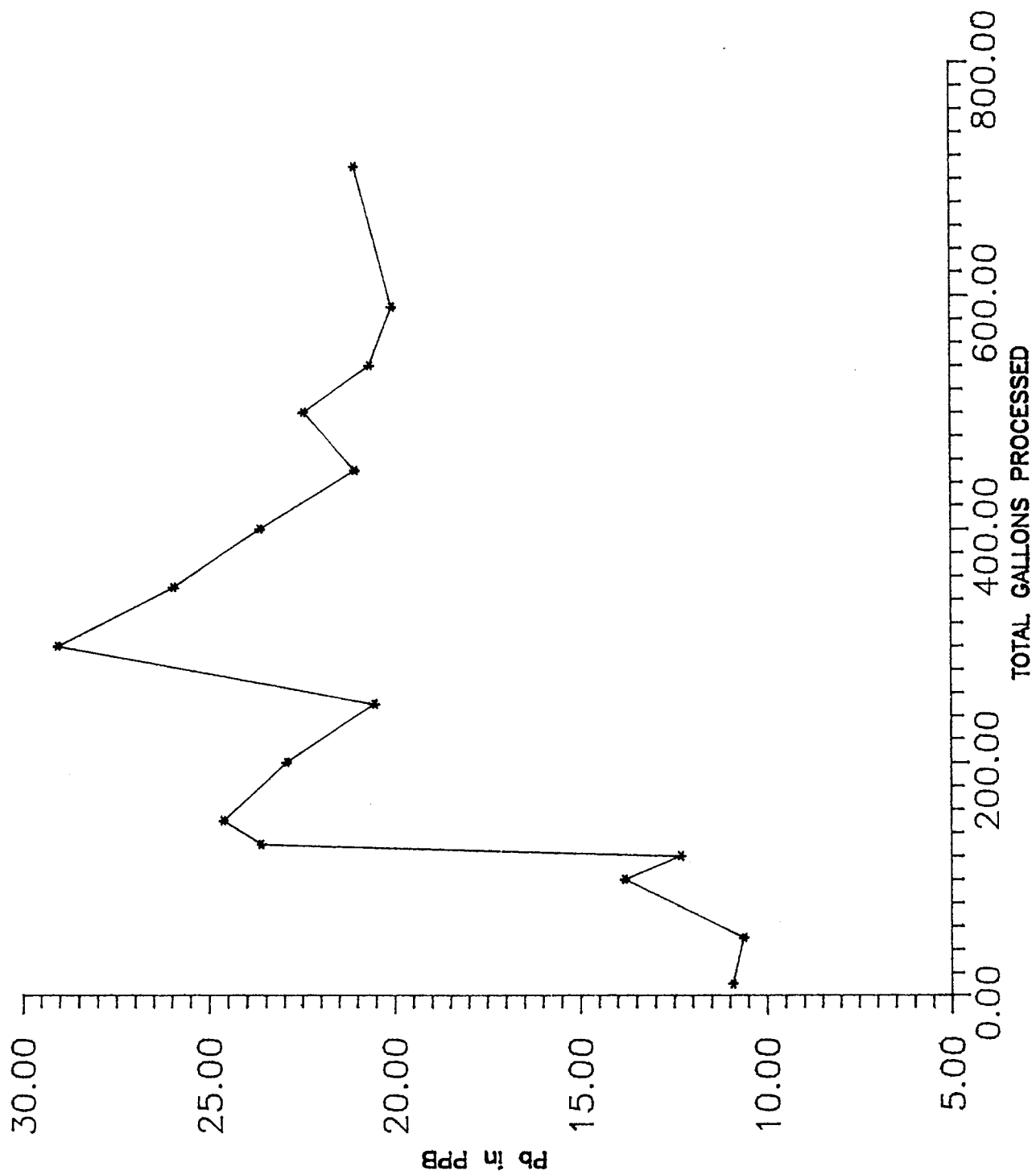


Figure 4.2-12. Plot of Column #1 Influent, Lead Levels

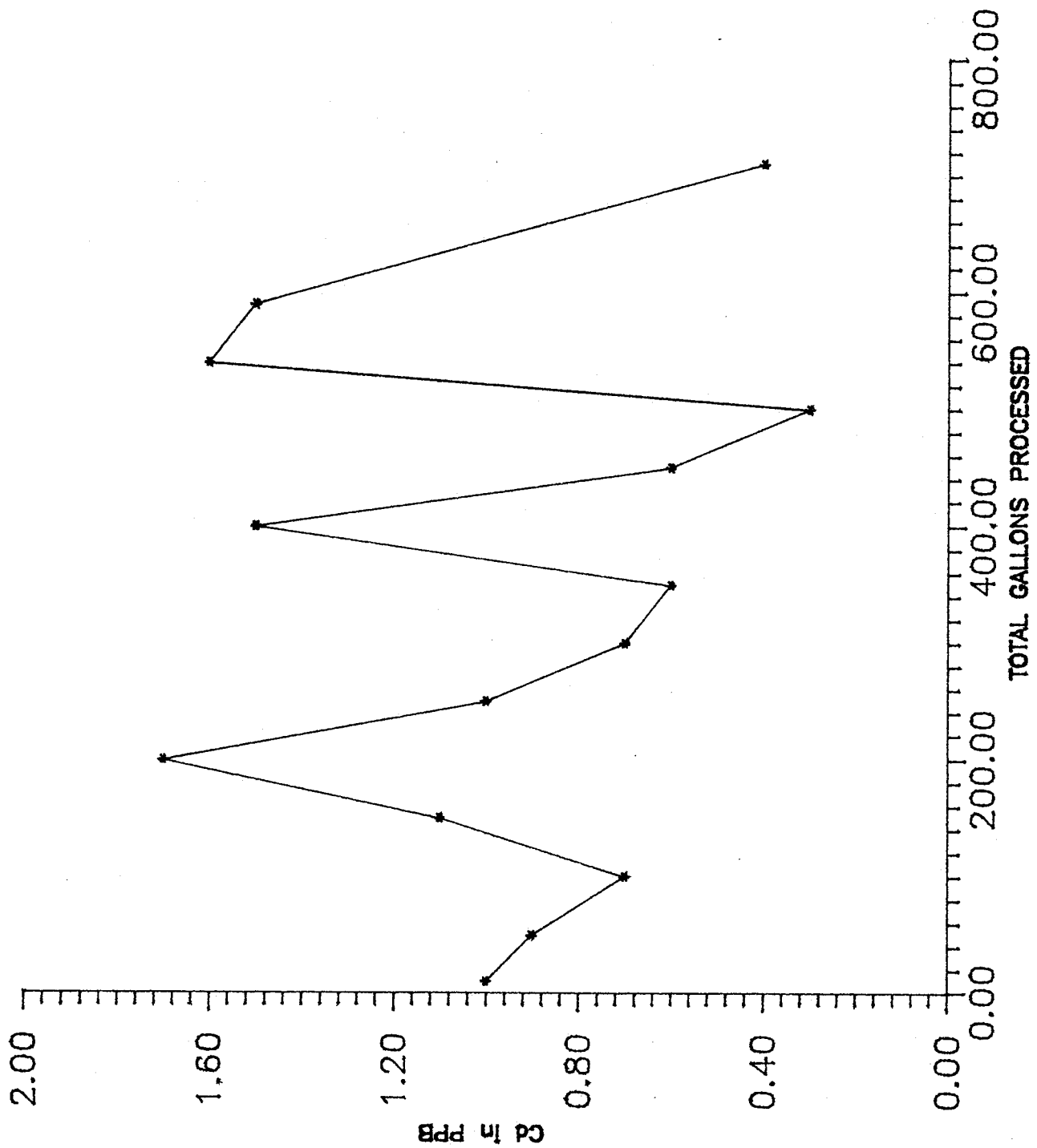


Figure 4.2-13. Plot of Column #2 Effluent, Cadmium Levels

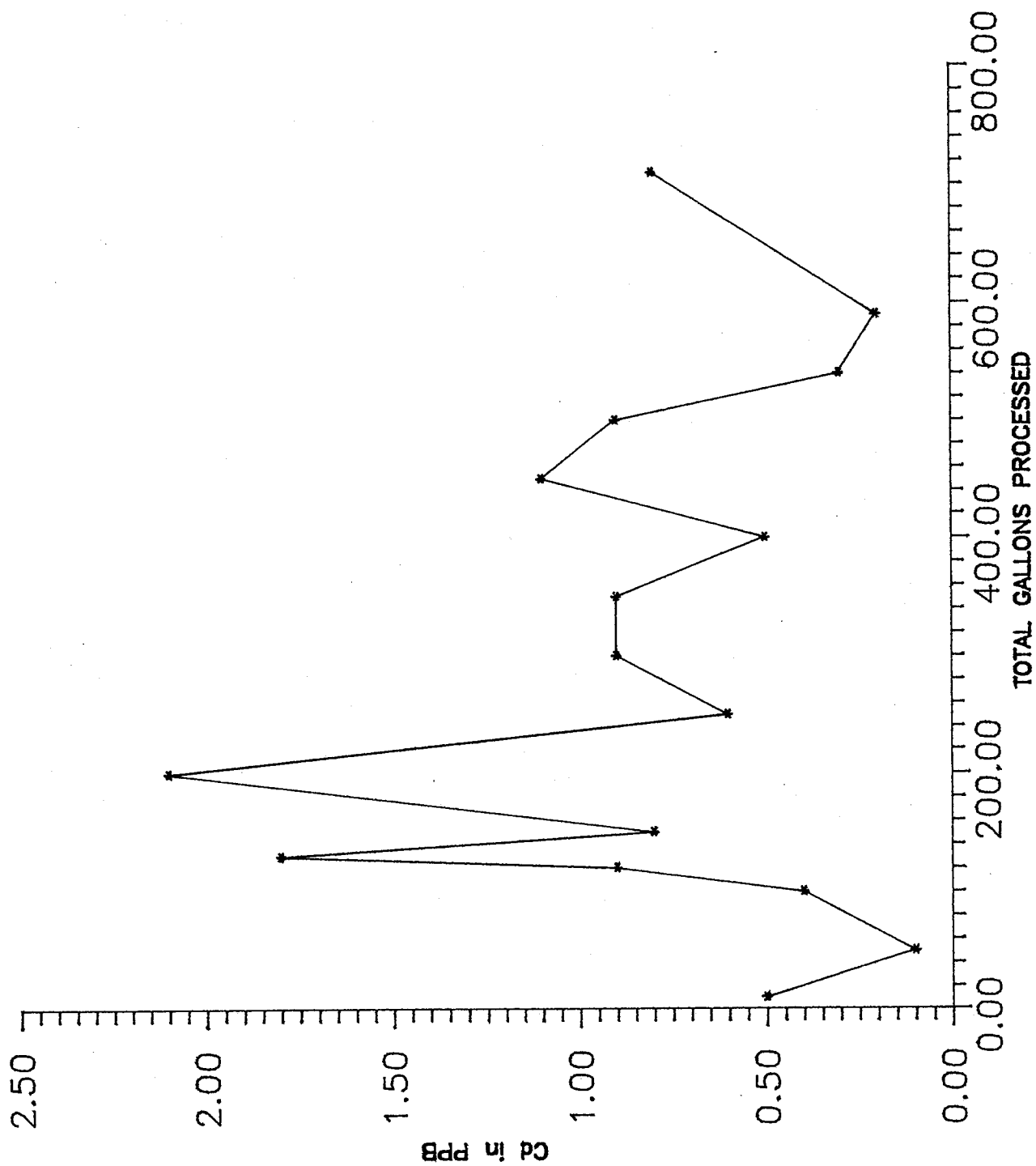


Figure 4.2-14. Plot of Column #2 Influent, Cadmium Levels

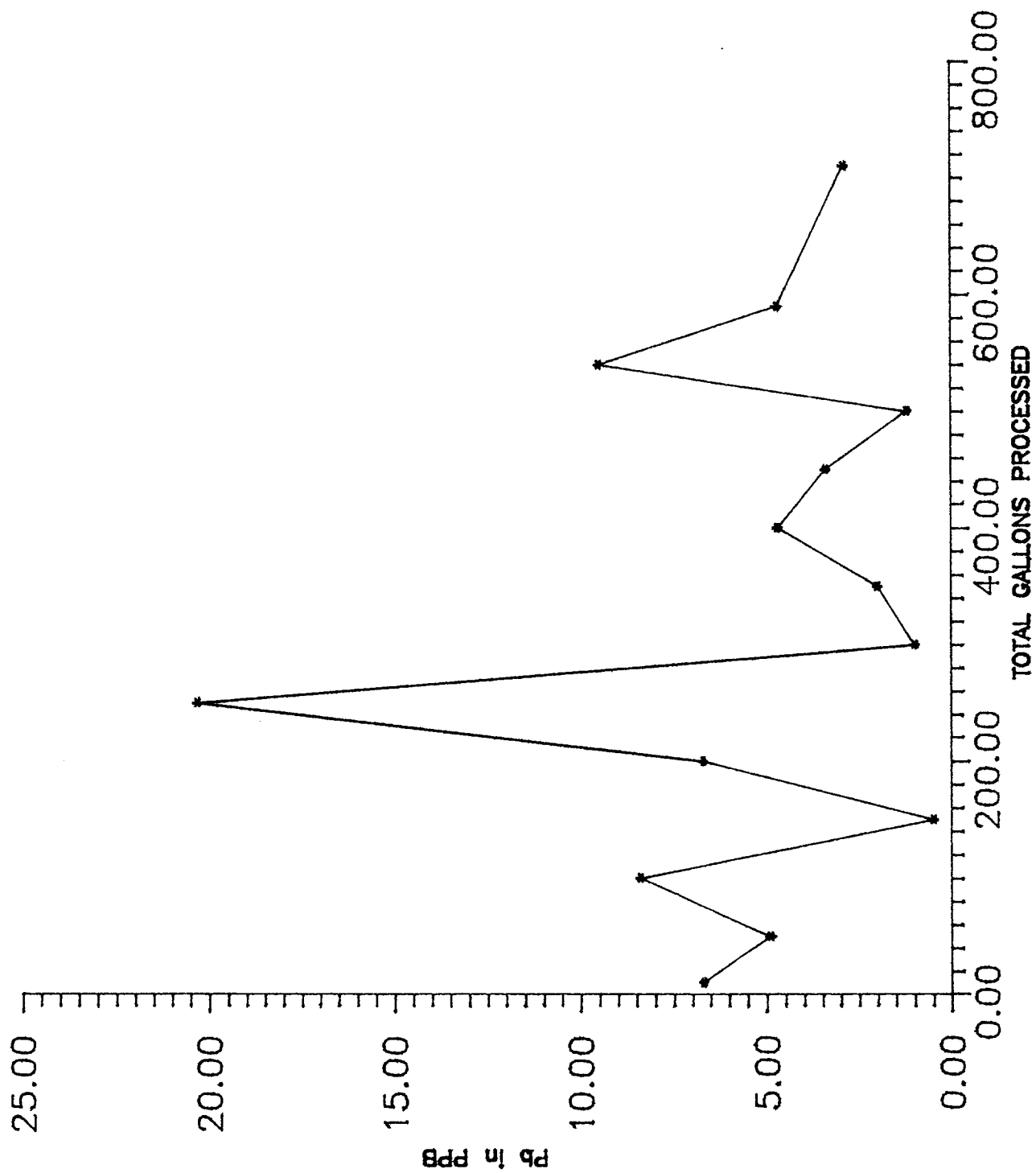


Figure 4.2-15. Plot of Column #2 Effluent, Lead Levels

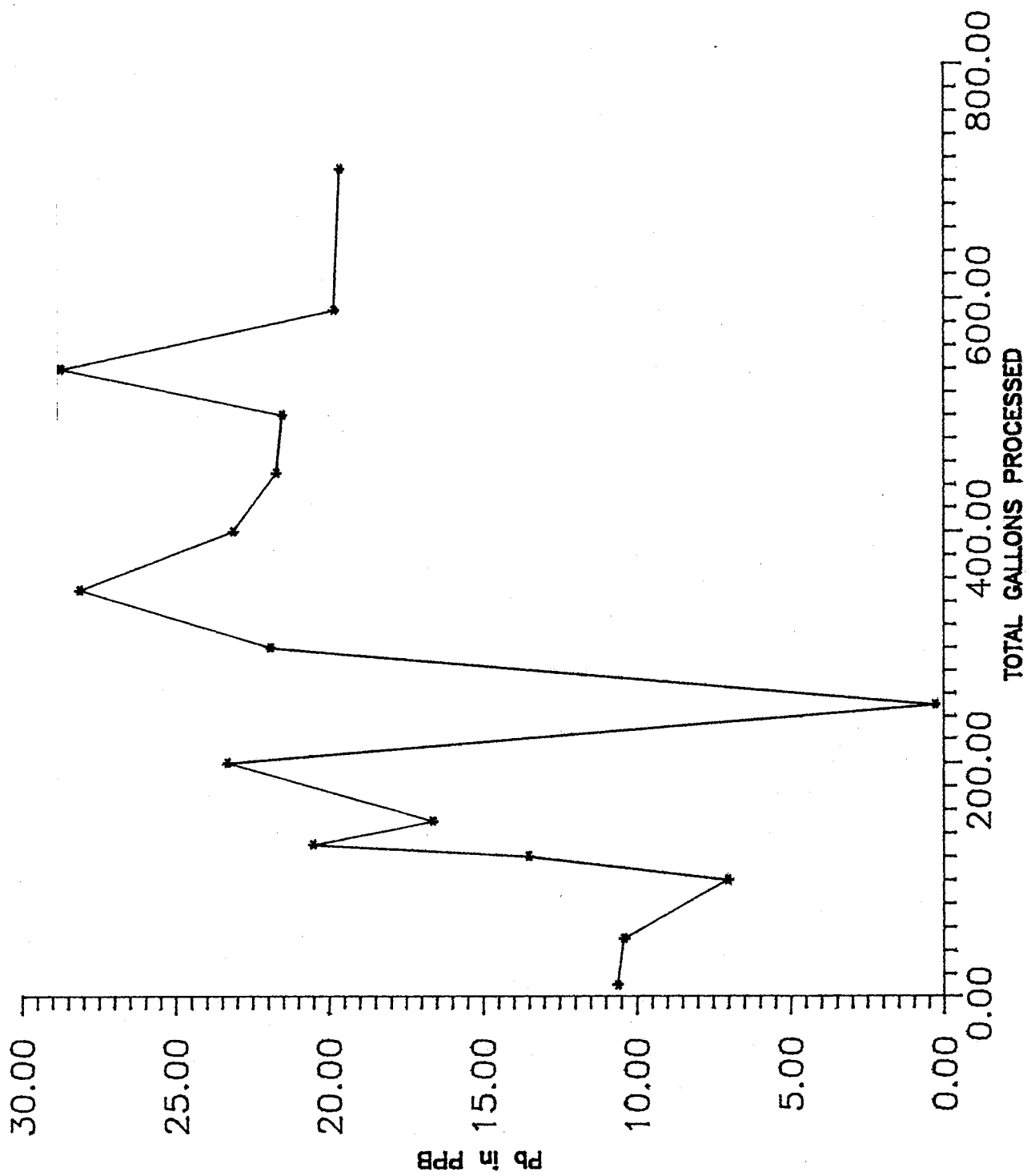


Figure 4.2-16. Plot of Column #2 Influent, Lead Levels

5.0 SELECTION OF TREATMENT METHOD

Based on the treatability testing, activated alumina adsorption is the preferred method of treatment for the water presently in the sump. Of the two treatment methods studied, only activated alumina adsorption provided treatment that achieved the proposed effluent levels for the contaminants of concern.

5.1 CONCEPTUAL DESIGN

A conceptual design of an activated alumina system was developed from the treatability test results. It includes a pH adjust system and two activated alumina columns. The system configuration is presented in Figure 5.1-1. Sump water is pumped into the pH adjust system where the pH is adjusted to 5.5. The water level in the pH adjust tank is controlled by a level controller. The pH adjusted water is pumped into the two activated alumina columns (which operate in parallel) with two positive displacement pumps. The flow rate into each of the columns is 1 gpm. This rate takes into account a 10 minute bed contact time and a bed volume of 1.4 ft³. The dimensions of the columns are 8 inches in diameter and 6 feet high. The activated alumina is either Alcoa type F-1 mesh size 14-28 or Kaiser type A-2 mesh size 12-32. The media bed depth is 4 feet. Although not shown in Figure 5.1-1, granular activated carbon (GAC) treatment of the alumina column effluent will be provided for IMPA removal, rather than completely relying on the GAC adsorbers at the RMA sanitary wastewater system to provide IMPA removal. The GAC unit will consist of two 55-gallon drums of GAC in series.

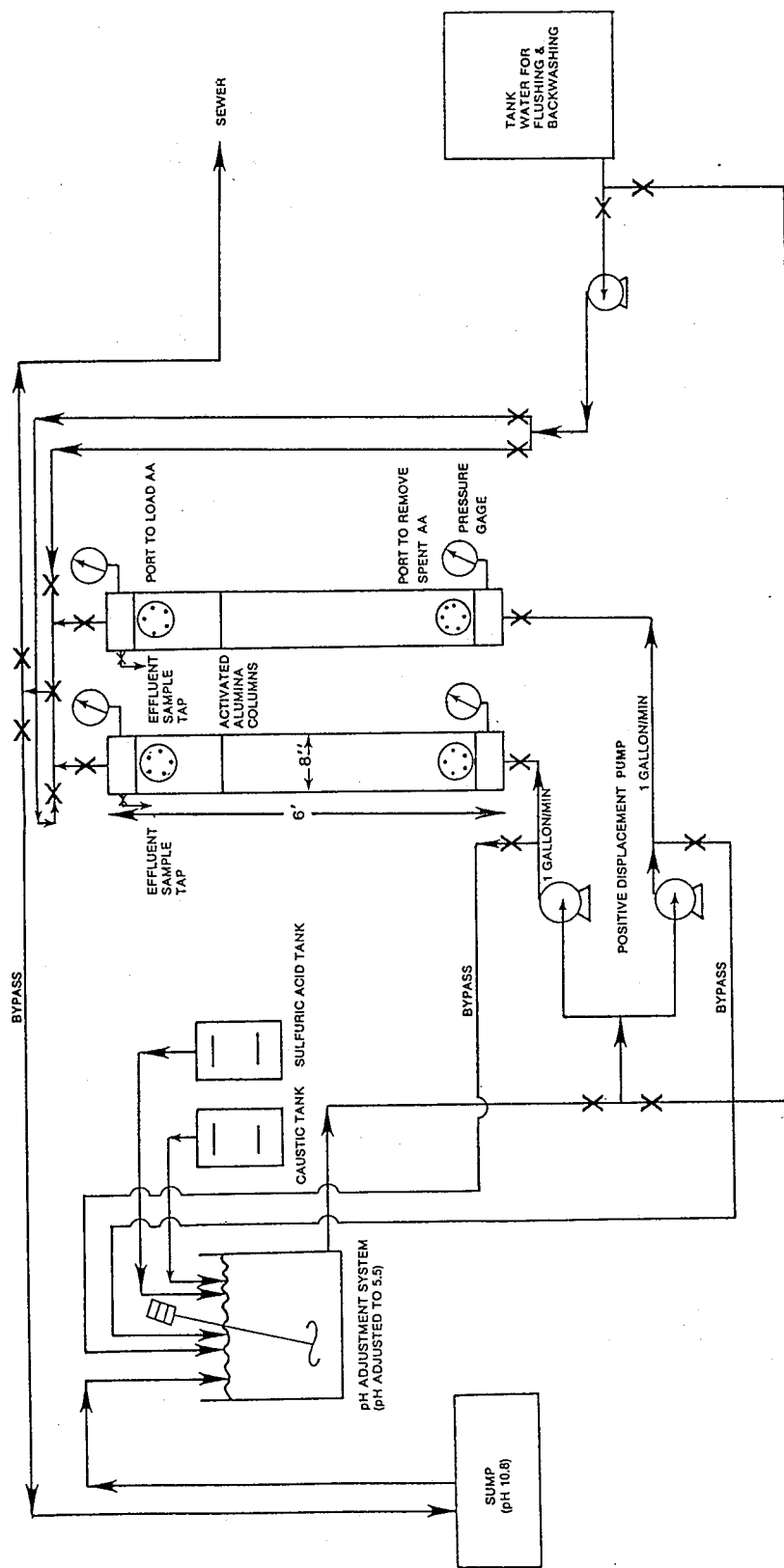


Figure 5.1-1
PROPOSED ACTIVATED ALUMINA PROCESS DIAGRAM

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

The system effluent will be sampled regularly to monitor the system. If the analyses indicates that the levels of arsenic and fluoride are below MCL levels, then the water is discharged to the sewer. If the arsenic and fluoride levels are not below the MCL levels the water will be directed back into the sump and retreated. The system effluent will also be monitored for IMPA to determine when the GAC will need to be replaced.

The activated alumina will be changed approximately every 27 hours (153 bed volumes). Therefore, it will take approximately 5500 pounds of activated alumina to treat 120,000 gallons of sump water. This is equivalent to approximately 75 charges of activated alumina. Using these figures it would take approximately 85 days, operating two columns to treat 120,000 gallons and load and backwash the columns after each charge. This time would also include maintenance on the pumps and the handling of spent activated alumina.

The time required to treat 120,000 gallons could be reduced to 43 days with two additional columns. This would eliminate down time for reloading and backwashing the columns. The additional two columns would increase the cost slightly, but would reduce total operation time by half.

As a third option, a larger alumina system consisting of one 18-inch diameter column 13 feet high could be used to reduce the frequency of replacing the spent alumina from 75 times to 7 times, and the alumina replacement would be performed on a weekly basis rather than every other day for the systems with the smaller columns. The total operation time for the 18-inch

column system would be reduced to approximately 56 days. The two-drum GAC unit will also be used for treatment of the alumina column effluent for IMPA removal.

An extraction procedure (EP) toxicity test was performed on a sample of the spent media from the treatability test to determine if the spent alumina was a characteristic hazardous waste as defined in 40 CFR Part 261.24. The test results are shown in Table 5.1-1. As shown in Table 5.1-1, the results indicate that the spent activated alumina is not a characteristic hazardous waste, although it will be handled as a hazardous waste because of the waste's association with GB operations.

The projected amount of activated alumina is only 5500 lbs. It is more cost-effective to directly dispose the spent activated alumina than to regenerate it. The amount of arsenic contaminated sodium hydroxide solution generated from a regeneration process would cost considerably more to treat and dispose than directly disposing the activated alumina. Also, even though regeneration cuts down on alumina usage, the cost savings do not justify regenerating the activated alumina. Disposal costs for the activated alumina as a hazardous waste would include transportation and burial.

Table 5.1-1. EP Toxicity Test Results for Spent
Activated Alumina

<u>Contaminant</u>	<u>EP Extract Concentration (mg/L)</u>	<u>Maximum Allowable Concentration (mg/L)*</u>
Arsenic	0.211	5.0
Barium	<0.0001	100
Cadmium	<0.0005	1.0
Chromium	<0.0005	5.0
Lead	<0.0001	5.0
Mercury	<0.0005	0.2
Selenium	0.0036	1.0
Silver	0.026	5.0

* 40 CFR Part 261.24

The proposed activated alumina treatment system was not designed to treat cadmium or lead. If the chemistry of the sump water changes, from what was indicated in this study, the system will have to be modified to address this change. If cadmium and lead are in suspended solids they may become a problem as the sediments are agitated from the removal and treatment of the water. One possible solution, if this is the cause of the cadmium and lead contamination, is to use a clarifier to settle the suspended solids out of the water before the water enters the pH adjust system.

5.2 ESTIMATED COSTS

Capital costs for the proposed activated alumina system with two 8-inch diameter alumina columns (Figure 5.1-1) were estimated to be approximately \$13,000. This includes all the equipment, raw materials, and installation and start-up labor. These costs are itemized in Table 5.2-1. Operation and maintenance costs for the entire treatment period were estimated to be approximately \$16,000. This cost includes labor and power costs for the 86 days of operation, chemical costs, and disposal costs for the spent alumina (see Table 5.2-2). Costs for chemical analysis to monitor the system are not included in Table 5.2-2.

If two additional columns were added to reduce the operation time from 86 days to 43 days, the net increase in cost would be approximately \$1,700. A breakdown of this estimated net increase is shown in Table 5.2-3.

If the 18-inch diameter alumina column system were used, the estimated capital cost for the entire system is approximately \$20,000. Table 5.2-4 presents an itemization of the estimated

capital cost for this system. Operation and maintenance costs for the entire treatment period were estimated to be approximately \$9,000. This cost includes labor and power costs for the 56 days of operation, chemical costs, and disposal costs for the spent alumina. Table 5.2-5 presents an itemization of the operation and maintenance costs, which do not include monitoring of the treatment system effluent.

Table 5.2-1. Capital Cost Estimate for the Proposed Activated Alumina Treatment System With Two 8-Inch Diameter Alumina Columns

ITEM	UNIT	COST (\$)	COST (\$)
* EQUIPMENT *			
pH ADJUST SYSTEM			
TANK (300 GALLON, PVC OR PE)		\$650.00	\$650.00
PUMP (1/2 HP, 3-5 GPM)		\$150.00	\$150.00
LEVEL CONTROLLER		\$172.00	\$172.00
2 CHEMICAL FEEDERS		\$143.23	\$286.46
MIXER (0.3 HP, S.S, SINGLE IMPELLER)		\$682.00	\$682.00
pH CONTROLLER		\$2,512.00	\$2,512.00
POSITIVE DISPLACEMENT PUMPS			
2 PUMPS		\$547.00	\$1,094.00
(1/2 HP, 1 GPM, DIAPHRAGM OR GEAR)			
MACHINED ACTIVATED ALUMINA COLUMNS			
2 ACTIVATED ALUMINA COLUMNS		\$200.00	\$400.00
(8" DIA., 6' TALL, SCH 80;			
TWO PORTS FOR A.A ADITION & REMOVAL;			
FLANGED ENDS W/ ONE TAP;			
MESH OR SCREEN ON INFLUENT END)			
MESH OR SCREEN & GLASS BEADS		\$50.00	\$50.00
4 PRESSURE GAUGES		\$21.19	\$84.76
(ONE FOR EACH OF THE COLUMNS,			
30-60 LBS)			
VALUES FITTINGS & PIPING			
	(1/2")	(1")	
PVC SCH 40 (400 FT, 1")**	\$0.12/FT	\$0.24/FT	\$96.00
TEES (1", APPROXIMATELY 10)**	\$0.21	\$0.44	\$4.40
ELBOWS (1", APPROXIMATELY 20)**	\$0.12	\$0.34	\$10.20
BALL VALVES (1", APPROXIMATELY	\$4.63	\$9.50	\$190.00
20)			
BACKWASHING & FLUSHING SYSTEM			
TANK (300 GALLONS)		\$650.00	\$650.00
PUMP (1/2 HP, 3-5 GPM)		\$150.00	\$150.00
GAC TREATMENT			
TWO DRUMS (200 LBS CARBON)		\$500	\$1,000.00
		TOTAL	\$8,181.82
* INSTALLATION & START-UP LABOR *			
3 DAYS ORGANIZATION (8 HRS/DAY)			
1 PERSON @ \$10.00/HR + O.H.		\$28.00	\$672.00
7 DAYS INSTALLATION (8 HRS/DAY)			
2 PERSON @ \$10.00/HR + O.H.		\$28.00	\$3,136.00
2 DAYS START-UP (8 HRS/DAY)			
1 PERSON @ \$10.00/HR + O.H.		\$28.00	\$1,030.40
1 PERSON @ \$13.00/HR + O.H.		\$36.40	
		TOTAL	\$4,838.40
TOTAL CAPITAL COST			\$13,020.22

** SIZE OF PIPE, FITTINGS & VALVES SHOULD BE DICTATED BY PUMP INLETS

Table 5.2-2. Operation and Maintenance Cost Estimate for the
Proposed Activated Alumina Treatment System With
Two 8-Inch Diameter Alumina Columns
(Page 1 of 2)

ITEM	UNIT COST (\$)	COST (\$)
<hr/>		
* LABOR *		

86 DAYS TOTAL OPERATION TIME (75 CHARGES) (43 DAYS TREATMENT TIME & 43 DAYS MAINTENANCE & RELOADING)		
43 DAYS (8 HRS/DAY) 1 PERSON @ 10.00/HR + OH	\$28.00	\$9,632.00
	TOTAL	\$9,632.00
<hr/>		
* POWER *		

OPERATION TIME		
24 HRS/DAY (43 DAYS, 1385 KWH) PUMP INTO pH ADJUST TANK (1/2 HP) MIXER (0.3 HP) 2 POSITIVE DISPLACEMENT PUMPS (1/2)	\$0.045/KWH	\$62.33
8 HRS/DAY (43 DAYS, 128 KWH) BACKWASHING & FLUSHING PUMP (1/2 HP)	\$0.045/KWH	\$5.76
	TOTAL	\$68.09
<hr/>		
* CHEMICALS *		

5500 LBS ACTIVATED ALUMINA (BULK RATE) (ALCOA F-1 14-28 OR KAISER A-2 12-32)	\$0.58/LB	\$3,190.00
70 GALLONS SULFURIC ACID (120 ML/55 GALLONS)	\$16.75/GAL	\$1,172.50
	TOTAL	\$4,362.50

Table 5.2-2. Operation and Maintenance Cost Estimate for the
Proposed Activated Alumina Treatment System With
Two 8-Inch Diameter Columns.
(Continued, Page 2 of 2)

ITEM	UNIT COST (\$)	COST (\$)
* SPENT ALUMINA DISPOSAL COST *		

APPROXIMATELY 12 DRUMS OF SPENT AA. (PER 120,000 GALLONS OF TREATED WATER)		
STABILIZATION	\$40.00/DRUM	\$560.00
TRANSPORTATION AND BURIAL	\$60.00/DRUM	\$840.00
MATERIAL PROFILE	\$200.00	\$200.00

	TOTAL	\$1,600.00

TOTAL OPERATION AND MAINTENANCE COST		\$15,662.59

Table 5.2-3. Cost Estimate for Two Additional 8-Inch Diameter Alumina Columns

ITEM	UNIT COST (\$)	COST (\$)
* ADDITIONAL EQUIPMENT *		
2 ACTIVATED ALUMINA COLUMNS	\$200.00	\$400.00
2 POSITIVE DISPLACEMENT PUMPS	\$547.00	
\$1,094.00		
MESH OR SCREEN & GLASS BEADS		\$50.00
4 GAUGES	\$21.19	\$84.76
VALVES, FITTINGS & PIPING		
\$100.00		
TOTAL ADDITIONAL CAPITAL COST		\$1,728.76
* ADDITIONAL LABOR COST *		
* LABOR COSTS ARE THE SAME AS THE TWO COLUMNS AND 86 DAYS OF OPERATION		
43 DAYS TOTAL OPERATION TIME (75 CHARGES) (43 DAYS TREATMENT, MAINTENANCE & RELOADING TIME)		
43 DAYS (8 HRS/DAY)		
1 PERSON @ 10.00/HR + OH	\$28.00	\$9,632.00
TOTAL ADDITIONAL LABOR COST		\$0.00
* ADDITIONAL POWER COST *		
NEGLECTIBLE		
* ADDITIONAL A.A. DISPOSAL COSTS *		
NONE		
TOTAL ADDITIONAL COST		\$1,728.76

Table 5.2-4. Capital Cost Estimate for the Proposed
Activated Alumina Treatment System With 18-Inch
Diameter Alumina Column

ITEM	UNIT COST (\$)	COST (\$)
* EQUIPMENT *		
pH ADJUST SYSTEM		
TANK (300 GALLON, PVC OR PE)	\$650.00	\$650.00
PUMP (1/2 HP, 3-5 GPM)	\$150.00	\$150.00
LEVEL CONTROLLER	\$172.00	\$172.00
2 CHEMICAL FEEDERS	\$143.23	\$286.46
MIXER (0.3 HP, S.S, SINGLE IMPELLER)	\$682.00	\$682.00
pH CONTROLLER	\$2,512.00	\$2,512.00
POSITIVE DISPLACEMENT PUMPS		
1 PUMP	\$450.00	\$450.00
(1/2 HP, 1 GPM, DIAPHRAGM OR GEAR)		
MACHINED ACTIVATED ALUMINA COLUMNS		
1 ACTIVATED ALUMINA COLUMN	\$6,868.00	\$6,868.00
(18" DIA., 13' TALL, SCH 80; TWO PORTS FOR A.A ADDITION & REMOVAL; MACHINED ENDS W/ ONE TAP; MESH OR SCREEN ON INFLUENT AND EFFLUENT END)		
MESH OR SCREEN & GLASS BEADS	\$50.00	\$50.00
2 PRESSURE GAUGES	\$21.19	\$42.38
(ONE FOR EACH OF THE COLUMNS, 30-60 LBS)		
MOUNTING SYSTEM		\$1,000.00
VALUES FITTINGS & PIPING	(1/2") (1")	
PVC SCH 40 (400 FT, 1")**	\$0.12/FT \$0.24/FT	\$96.00
TEES (1", APPROXIMATELY 10)**	\$0.21 \$0.44	\$4.40
ELBOWS (1", APPROXIMATELY 20)**	\$0.12 \$0.34	\$10.20
BALL VALVES (1", APPROXIMATELY 20)	\$4.63 \$9.50	\$190.00
BACKWASHING & FLUSHING SYSTEM		
TANK (300 GALLONS)	\$650.00	\$650.00
PUMP (1/2 HP, 3-5 GPM)	\$150.00	\$150.00
GAC TREATMENT		
TWO DRUMS (200 LBS CARBON)	\$500	\$1,000.00
	TOTAL	\$14,963.44
* INSTALLATION & START-UP LABOR *		
3 DAYS ORGANIZATION (8 HRS/DAY)		\$672.00
1 PERSON @ \$10.00/HR + O.H.	\$28.00	
7 DAYS INSTALLATION (8 HRS/DAY)		\$3,136.00
2 PERSON @ \$10.00/HR + O.H.	\$28.00	
2 DAYS START-UP (8 HRS/DAY)		\$1,030.40
1 PERSON @ \$10.00/HR + O.H.	\$28.00	
1 PERSON @ \$13.00/HR + O.H.	\$36.40	
	TOTAL	\$4,838.40
TOTAL CAPITAL COST		\$19,801.84
** SIZE OF PIPE, FITTINGS & VALVES SHOULD BE DICTATED BY PUMP INLETS AND OUTLETS. (PROBABLY WILL BE BETWEEN 1/2"-1")		

Table 5.2-5. Operation and Maintenance Cost Estimate for the
Proposed Activated Alumina Treatment System
With 18-Inch Diameter Alumina Column
(Page 1 of 2)

ITEM	UNIT	
	COST (\$)	COST (\$)
* LABOR *		

56 DAYS TOTAL OPERATION TIME (7 CHARGES) (42 DAYS TREATMENT TIME & 14 DAYS MAINTENANCE & RELOADING)		
14 DAYS (8 HRS/DAY)		
1 PERSON @ 10.00/HR + OH	\$28.00	\$3,136.00

	TOTAL	\$3,136.00
* POWER *		

OPERATION TIME		
24 HRS/DAY (42 DAYS, 1353 KWH)	\$0.045/KWH	\$60.89
PUMP INTO pH ADJUST TANK (1/2 HP)		
MIXER (0.3 HP)		
2 POSITIVE DISPLACEMENT PUMPS (1/2)		
8 HRS/DAY (14 DAYS, 42 KWH)	\$0.045/KWH	\$1.89
BACKWASHING & FLUSHING PUMP (1/2 HP)		

	TOTAL	\$62.78
* CHEMICALS *		

5500 LBS ACTIVATED ALUMINA (BULK RATE)		
(ALCOA F-1 14-28 OR KAISER A-2 12-32)	\$0.58/LB	\$3,190.00
70 GALLONS SULFURIC ACID		
(120 ML/55 GALLONS)	\$16.75/GAL	\$1,172.50

	TOTAL	\$4,362.50

Table 5.2-5. Maintenance Cost Estimate for the
Proposed Activated Alumina Treatment System
18-Inch Diameter Alumina Column
(Continued, Page 2 of 2)

Operation and
With

ITEM	UNIT COST (\$)	COST (\$)
* SPENT ALUMINA DISPOSAL COST *		

APPROXIMATELY 14 DRUMS OF SPENT AA. (PER 120,000 GALLONS OF TREATED WATER)		
STABILIZATION	\$40.00/DRUM	\$560.00
TRANSPORTATION AND BURIAL	\$60.00/DRUM	\$840.00
MATERIAL PROFILE	\$200.00	\$200.00
	TOTAL	----- \$1,600.00
TOTAL OPERATION AND MAINTENANCE COST		\$9,161.28

REFERENCES

Prusinski, Dennis M., November 1978, North Boundary Fluoride Removal Studies at Rocky Mountain Arsenal, Process Development and Evaluation Division of the Contamination Control Directorate.

Rubel and Hager, Inc., August 1980, Pilot Test Program Removal of Excess Fluoride from Activated Carbon Effluent, Prepared for Department of the Army Rocky Mountain Arsenal.

Rubel and Hager, Inc., September 1978, Feasibility Study for the Removal of Excess Fluoride from Activated Carbon Effluent, Prepared for Department of the Army Rocky Mountain Arsenal.

Rubel, Jr., Frederick and Hathaway, Steven W., September 1985, Pilot Study for Removal of Arsenic from Drinking Water at the Fallon, Nevada, Naval Air Station, Environmental Protection Agency, EPA 600/52-85/094.

Rubel, Jr., Frederick and Woosley, Dale, January 1979, The Removal of Excess Fluoride from Drinking Water by Activated Alumina, Journal AWWA.

Thompson, Douglas W., Terkonda, Purush K., Streebin, Leale E., January 1980, Treatment and Disposal of Regeneration Wastewater from Activated Alumina Columns Used for Fluoride Removal From Ground Water at Rocky Mountain Arsenal, Environmental Laboratory U. S. Army Engineer Waterways Experiment Station.

U.S. Environmental Protection Agency (EPA), January 1978, Removal of Excess Fluoride from Drinking Water, EPA 570/9-78-001.

U.S. Environmental Protection Agency (EPA), 1983, Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020.

U.S. Environmental Protection Agency (EPA), August 1984, Design Manual: Removal of Fluoride from Drinking Water Supplies by Activated Alumina, EPA 600/2-84-134.

APPENDIX A

ANALYTICAL RESULTS FOR

SUMP 1727 WATER SAMPLES

COLLECTED IN FEBRUARY 1987

JYM →
Does RVB
Know About
As.?

ZAS

RMA42-EDEN-USA-T-007

April 13, 1987

Commander, Office of the Program Manager for
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE/(K. Blose)
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010-5401

Subject: North Plants Bldg. 1727 Sampling

Dear Kevin:

As a followup to the results I transmitted to you on April 6, 1987 regarding the analysis of the water sample collected from the Bldg. 1727 sump, I have received the following results from UBTL/Datachem:

Parameter	Result, ug/l
Arsenic	17,800
Target Volatile Organics	BDL
DIMP	<19
DMMP	<30

I believe that this completes the results for this sample. Bear in mind that none of these data have yet cleared the Level II acceptance routines, so they

4/14/87

Page 2

must be considered preliminary at this point. I will let you know when the data are accepted. Please advise if you have any questions.

Sincerely yours,
EBASCO SERVICES INCORPORATED

Preston Chiaro

Preston S. Chiaro, P.E.
RI Technical Manager

cc: D. Campbell, PMO
K. Wiggans, PMO
~~REDACTED~~ ESE
J. Silvey
J. Keithley
K. Knirsch
S. Turner
DCC/Denver/Santa Ana
Chron file

EBASCO SERVICES INCORPORATED

143 Union Boulevard, Suite 1010, Lakewood, CO 80228-1824, (303) 988-2202

ROCKY MOUNTAIN ARSENAL
PREPARED BY EBASCO SERVICES INCORPORATED

EBASCO

RMA42-EDEN-USA-T-006

April 6, 1987

Commander, Office of the Program Manager for
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE/(K. Blose)
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010-5401

Subject: North Plants Bldg. 1727 Sampling

Dear Kevin:

As a followup to the results I transmitted to you on March 31, 1987 regarding the analysis of the water sample collected from the Bldg. 1727 sump, I have received the following results from UBTL:

Parameter	Result, ug/l
IMPA	19000
Target Semivolatile Organics	BDL
UNK 1*	10
UNK 2*	66
Zinc	<25

UNK 1 was tentatively identified as a phthalate. UNK 2 was tentatively identified as N-N' bis-(1-methylethyl) urea. I did not yet receive results for

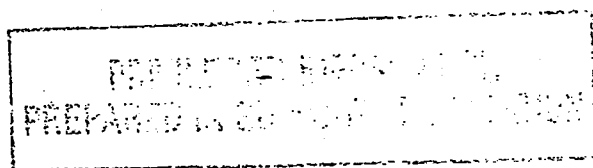
arsenic or the volatile organics, but I expect to have them shortly. The remaining Army degradation product analyses may take a little longer. Please advise if you have any questions.

Sincerely yours,
EBASCO SERVICES INCORPORATED

Preston Chiaro

Preston S. Chiaro, P.E.
RI Technical Manager

cc: D. Campbell, PMO
K. Wiggans, PMO
Z. Smith, ESE
J. Silvey
J. Keithley
K. Knirsch
S. Turner
DCC/Denver/Santa Ana
Chron file



EBASCO SERVICES INCORPORATED

EBASCO

143 Union Boulevard, Suite 1010, Lakewood, CO 80228-1824, (303) 988-2202

RMA42-EDEN-USA-T-005

March 31, 1987

Commander, Office of the Program Manager for
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-BE/(K. Blose)
Building E4585 - DBL Trailer
Aberdeen Proving Ground
Maryland 21010-5401

Subject: North Plants Bldg. 1727 Sampling

Dear Kevin:

As a followup to the results I transmitted to you on March 24, 1987 regarding the analysis of the water sample collected from the Bldg. 1727 sump, I have received the following results from UBTL today:

Parameter	Result, ug/l
Cadmium	551
Calcium	8,160
Chromium	<24
Copper	41.5
Lead	250
Magnesium	15,400
Mercury	1.2
Potassium	20,200
Sodium	1,040,000

I did not yet receive results for arsenic or zinc, but I expect to have them within a day or two. Also, I expect to receive the volatile and semivolatile

analyses within a few days. The Army degradation product analyses may take a little longer. Please advise if you have any questions.

Sincerely yours,
EBASCO SERVICES INCORPORATED

Preston Chiaro

Preston S. Chiaro, P.E.
RI Technical Manager

cc: D. Campbell, PMO
K. Wiggans, PMO
Z. Smith, ESE - *Denver*
J. Silvey
J. Keithley
K. Knirsch
S. Turner
DCC/Denver/Santa Ana
Chron file

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL

SUBJECT

SMCRM-CCT

Bldg 1727 Waste Liquid Sump Sample Results

TO SMCRM-CCS

FROM SMCRM-CCT

DATE 17 March 1987

CMT 1

pl/194

1. Attached are the analytical results for the building 1727 waste liquid sample submitted 23 Feb 1987. Because it was proposed that this liquid be disposed using the sanitary sewer system, additional analyses were added to the original request.
2. Summary - Analyses indicate below detectable levels for all analyzed contaminants except for fluoride (see page 2) and diisopropyl urea (see page 3, GC-MS spectrum). Both contaminants are possible products of GB decontamination activities. The fluoride concentration of 12.4 milligrams/liter exceeds the EPA maximum contaminant level (MCL) for potential drinking water sources of 4.0 milligrams/liter and the pH of 10.1 exceeds the maximum allowed by the arsenal's NPDES permit for the sewage treatment plant of 9.0.
3. If these are any questions or additional information needed, the POC is the undersigned.

Elijah G. Jones

ELIJAH G. JONES

Chief, Technical Support Division

CF
SMCRM-CO
SMCRM-IS
SMCRM-CC
SMCRM-CCS (Mr. Stallworth)
AMXRM-PM-R (Mr. Strang)

REQUEST FOR AND RESULTS OF TESTS

PAGE NO.

1

NO. OF PAGES

3

SECTION A - REQUEST FOR TEST

1. TO: (Include ZIP Code)

Lab, B313
ATTN: E. Jones

2. FROM: (Include ZIP Code)

Systems Opns Division
ATTN: B. Stallworth

3. PRIME CONTRACTOR AND ADDRESS (Include ZIP Code)

N/A

4. MANUFACTURING PLANT NAME AND ADDRESS (Include ZIP Code)

CONTRACT NUMBER

P. O. NUMBER

5. END ITEM AND/OR PROJECT

Bldg 1727 Sump Water

6. SAMPLE
NUMBER

7. LOT NO.

8. REASON FOR SUBMITTAL

9. DATE
SUBMITTED

23 FEB 87

10. MATERIAL TO BE
TESTED

Water

10a. QUANTITY
SUBMITTED

1 Gal

11. QUANTITY
REPRESENTED12. SPEC. & AMEND AND/OR DRAWING NO. & REV.
FOR SAMPLE & DATE

13. PURCHASED FROM OR SOURCE

Bldg 1727 Liquid Waste Sump

14. SHIPMENT METHOD

HC

15. DATE SAMPLED AND SUBMITTED BY

Robert R. Stallworth

16. REMARKS AND/OR SPECIAL INSTRUCTIONS AND/OR WAIVERS.

Test for:

1. G Agent
2. H Agent
3. EP Tox Test
4. GC Mass Scan

17. SEND REPORT OF TEST TO

1 copy to CC, Dir

1 Copy to Dir, IS

1 copy to PMSO, G. Barbieri

1 copy to B. Stallworth

SECTION B - RESULTS OF TEST (Continue on plain white paper if more space is required)

1. DATE SAMPLE RECEIVED

23 February 1987

2. DATE RESULTS REPORTED

2 March 1987

3. LAB REPORT NUMBER

450559

4. TEST PERFORMED

RESULTS OF TEST

SAMPLE RESULT

REQUIREMENTS

SEE ATTACHED REPORTS

DATE

16 March 1987

TYPED NAME AND TITLE OF PERSON CONDUCTING TEST

ELIJAH G. JONES
Supervisory Chemist
Technical Support Division

SIGNATURE

Elijah G. Jones

DD FORM 1222

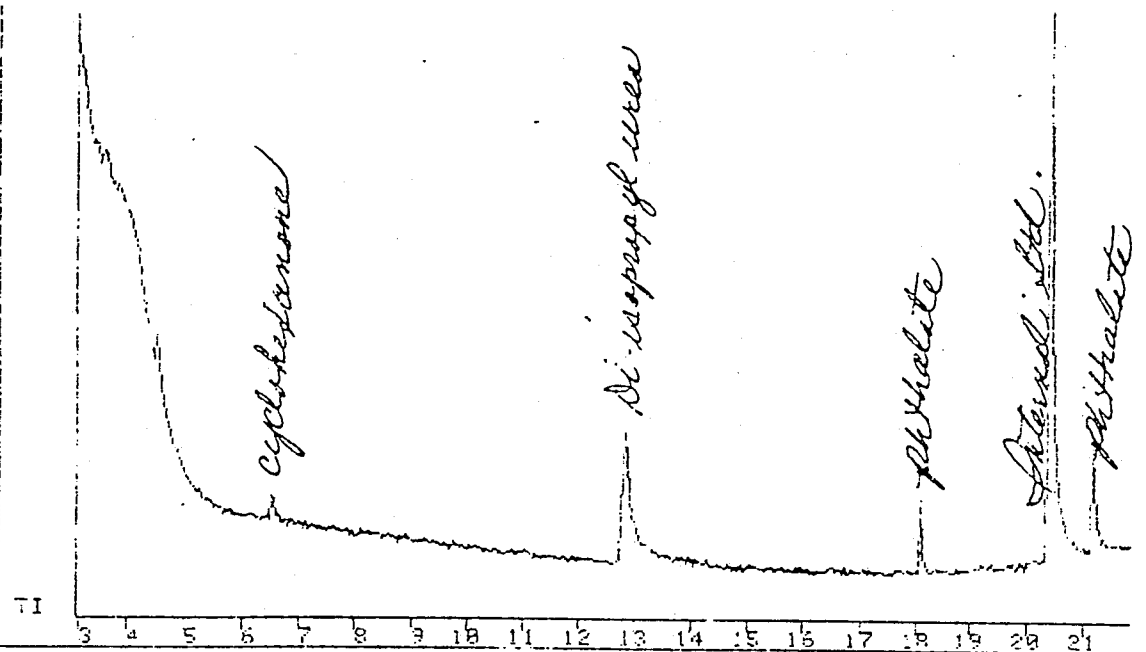
REPLACES DD FORM 1222, 1 JUL 58, WHICH IS OBSOLETE

BUILDING 1727 LIQUID WASTE SUMP SAMPLE (23 FEB 1987) ANALYSIS RESULTS

ROCKY MOUNTAIN ARSENAL LABORATORY REPORT

USER NUMBER	SAMPLE IDENT.	LAB NUMBER	I D	DATE IN	DATE DONE	TEST	MT	BO	VALUE	UNIT
M70031	B17278	A50559	W	87054	87054	12DCLE	T1	LT	1	UGLS ...SQIS
					87055	24D	T1	LT	8	UGL ...NOQC
					87054	ALDRN	R1	LT	0.2	UGL ...QUAN
					87054	CCL4	T1	LT	1	UGLS ...SQIS
					87054	CHCL3	T1	LT	1	UGLS ...SQIS
					87071	CL	R1		213	MGL ...NOQC
					87057	CPMS	R1	LT	20	UGL ...QUAN
					87057	CPMS01	R1	LT	20	UGL ...SQES
					87057	CPMS02	R1	LT	20	UGL ...SQES
					87054	DBCP	R1	LT	0.2	UGL ...QUAN
					87054	DCPD	T1	LT	1	UGLS ...SQIS
					87057	DIMP	R1	LT	10	UGL ...QUAN
					87057	DITH	R1	LT	20	UGL ...QUAN
					87054	DLDRN	R1	LT	0.2	UGL ...QUAN
					87054	ENDRN	R1	LT	0.2	UGL ...QUAN
					87061	S	R1		12.4	MGL ...QUAN
					87056	GB	T1	LT	4	UGL ...NOQC
					87056	H	T1	LT	8	UGL ...NOQC
					87054	ISODR	R1	LT	0.2	UGL ...QUAN
					87055	LIN	T1	LT	2	UGL ...NOQC
					87054	MECSH5	T1	LT	1	UGLS ...SQIS
					87055	NEXCLR	T1	LT	20	UGL ...NOQC
					87057	OXAT	R1	LT	20	UGL ...SQES
					87058	PH	R1		10.1	...NOQC
					87055	SILVEX	T1	LT	1	UGL ...NOQC
					87067	TOC	R1		26.2	MGL ...QUAN
					87054	TROLE	T1	LT	1	UGLS ...SQIS
					87055	TXPHEN	T1	LT	25	UGL ...NOQC
					87056	VX	T1	LT	37	UGL ...NOQC

						MSSCAN--Completed				



SPECTRUM DISPLAY/EDIT ##
H53559 BLDG 1727 SUMP 1 LTR/1ML W/INT STD
23 FEB 87 STD COND

FRM 3374
1ST SC/PG: 450
X= .50 Y= 1.00

